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RECENT ELECTRICAL PROGRESS

The necessities of war have stirred up the inventive genius of the country and many new devices have been made and more old ones improved upon. Unfortunately, because of the need of secrecy, it has not been possible to put more than a few of these improvements on the market. It is only since the war has ended that the phenomenal improvements in the wireless telephone have been disclosed to the general public. The remarkable results obtained by this improved means of communication between points on the ground and airplanes manoeuvering overhead, have no doubt been an exceedingly important factor in the winning of the war.

Wireless telegraphy can scarcely be considered as a recent invention, although it is only within the last few years that this system of communication has been so perfected as to make it a commercial asset. Trans-Atlantic wireless telegraphy is now a common thing. Points separated by vast distances are now in direct communication with each other. In all of the extension and development of wireless telegraphy there has been one factor which has persistently opposed every effort of those engaged in expanding this means of communication. This factor has been the disturbing influence of static electricity produced by various causes and existing in more or less quantities in the atmosphere. Much time and study have been devoted by wireless men to find some means of overcoming this hampering and annoying factor, and now the announcement has been made that after years of work a device has been constructed whereby the interference of static electricity can be satisfactorily eliminated. This device will doubtless make it possible still further to increase the vast distances between points of communication. With this new invention and with subsequent improvements in the wireless telephone it is not too much to prophesy that conversation between two persons separated by half of the earth's circumference may one day be an accomplished fact.

From another field comes the startling announcement of a tremendous increase in the capacity of telephone lines. Until very recently one telephone conversation was all that could be carried on over a single pair of wires. It was true that by using two such circuits, or four wires, thus securing what was known as a "phantom" circuit, that a third conversation would be superimposed upon the two metallic circuits, and three conversations be carried simultaneously. It has also been possible to use the same wires for both telegraph and telephone purposes, both methods of communication being carried on at the same time. For a long time it was thought that these were the limitations that could be imposed upon a single pair of wires, but a recent announcement by Theodore N. Vail, president of the American Telephone & Telegraph Company, shows how erroneous this supposition has been. With a new system, which has just been developed to a practical point, it is possible to carry on four telephone conversations over a single pair of wires, in addition to the conversation provided by the ordinary methods. This means that five telephone conversations are simultaneously operated, each giving service as good as that provided by the circuits working in the ordinary way. Sensational results have also been obtained by this new system in telegraphy By applying the new apparatus and methods to a metallic telephone circuit, the capacity of the wire for telegraphic messages has been enormously increased. The nature of these developments is such that if desired, wires may be used partly for telephone and partly for telegraph purposes. A single pair of wires is available either for five simultaneous telephone conversations or for the remarkable number of forty simultaneous telegraph messages, or partly for one and partly for the other.

While electric arc welding is something that cannot be considered as new, the progress that has been made in this art during the period in which the United States was engaged in war, is remarkable. Probably the greatest stimulus was given to arc welding by its application to shipbuilding work in the Emergency Fleet Corporation. Its value in connection with this work was early recognized and every possible step was taken to develop it. The result has been that many new things have been learned in connection with arc welding and its application to various industries has been greatly extended. In the railroad field, where so much of the material used is iron and steel, the uses of arc welding are practically unlimited. There are few departments on the railroad that cannot use arc welding to effect great economies. One of the more recent applications is seen in the building up of worn parts of track material, such as angle bars, switch points, worn frogs, etc.

Both direct current and alternating current are being used in welding practice. Each system has its advantages and disadvantages and each system has its advocates. It cannot be said that absolute perfection has been obtained with either system; there is much room for improvement in each. Be that as it may, however, the indications are that the coming year will see a greatly extended use of electric arc welding on the railroads and with this increase in use there will naturally follow developments and improvements which will bring the welding apparatus more nearly to the point of perfection.

CONSERVATION OF COAL AND OIL

The question of conserving the fuel resources of this country is one which cannot be voiced too frequently. Our railroads, which rank high on the list of users of vast quantities of fuel, can, should and will be eventually obliged to assist in the conservation of coal and oil by a vastly greater use of electricity for their operation.

These facts were recently brought to the attention of the director-general of the United States Railroad Administration by the director of the Pacific Coast section of the Oil Division of the Fuel Administration. Tentative plans and estimates have been prepared for the electrification of 510 miles of road in the Pacific coast section. The total estimated cost of this electrification is put at $23,000,000. Oil burning locomotives are used very extensively in California and at the present time the rate of oil consumption is between ten and eleven million barrels a year. It is estimated that if the required electric power were generated by the use of fuel oil the saving would be fully one-half.

If such savings can be accomplished on the Pacific coast, and there is every reason to believe that they can be, the question of conserving the fuel resources of the United States is of greatest importance and a careful and diligent study should be made of it in order that fuel saving policies may be put into practice with the least possible delay.

The fact that the fuel resources of this country are so abundant has led to the false impression that they are practically inexhaustible. A little thoughtful consideration will show that this widespread impression is a decided fallacy. Oil wells that have been known as "gushers" have ceased to flow; oil fields that have been the greatest producers have become almost barren; natural gas is not nearly so abundant as formerly; coal mining becomes more and more difficult each succeeding year.

There are portions of this country which are not nearly so well favored as others in their fuel deposit. Such sections must depend for their development upon coal and oil that is carried to them. It therefore behooves the engineers of the United States to give this great fuel problem their earnest consideration and the electrification of railroads in territories where water power is abundant would be no small step in the right direction.

NEED FOR A NEW LIGHTING UNIT

At a recent gathering of illuminating engineers the question of supplying light to box cars while they were being loaded was briefly considered. One of the men present described a crude arrangement that had come to his notice, consisting of an ordinary kerosene lantern fitted with an incandescent lamp socket inside the globe, attached to an extension cord. Questioning the foreman of the loading platform concerning the unusual arrangement brought out the fact that this queer combination was highly thought of for the reason that it could be set anywhere, hung anywhere and that the lamp was not continually being broken. That this freak lighting unit possesses versatility cannot be denied and it might not be altogether a bad idea if some consideration were given to the design of a more suitable electric lamp, which embodied the desirable features of this unusual combination.

THE GENERAL RAILWAY SITUATION

Director General McAdoo, who has resigned after heading the Railroad Administration for the first year of its existence, is advocating a five-year extension to federal control of the railroads in order fully to demonstrate the advantages of unified operation under peace or normal conditions. The general impression seems to be that it would be unwise to attempt to do this; it would practically amount to government ownership of the roads because they would be so thoroughly scrambled in the experiment that it would be impossible to separate them and return them to their owners. Public opinion is strongly opposed to the inefficiency, red tape, and bureaucracy which are characteristic of government ownership and which are diametrically opposed to American ideals.

Meanwhile, the Senate committee on interstate and foreign commerce is holding a series of hearings on the railroad question. Only a few weeks are available for this investigation by the present Congress and only a limited number of representatives from the different organizations and interests can be heard. The railroad executives have held several meetings and it is reported that they have agreed upon certain recommendations or suggestions that will be made to Congress.

The wisest course to follow will be to provide a constructive and responsible central regulation, and at the same time take advantage of the initiative which is so characteristic of private ownership.

LETTERS TO THE EDITOR

Concerning Alternating Current Welding

To the Editor:

The statements made in Mr. Anderson's article in last month's issue of the *Railway Electrical Engineer,* on alternating current arc welding cannot be accepted as a correct analysis of the situation. Not only is alternating current for arc welding feasible, but it has been proven in innumerable tests superior and more reliable than direct current. The statement made by the chief engineer of one of our large shipyards sums up the situation very aptly: "When welding with direct current, sometimes you weld and sometimes you don't ; when welding with alternating current, you always weld."

The advantages of alternating current for arc welding are briefly as follows:

1. Very remote liability of "burning" the weld.
2. Constant heat at the arc.
3. No complexity of apparatus, such as motor-generator set, resistance grids, contactors, exciters, etc.
4. Deeper penetration.
5. Portability of apparatus.
6. Very low power consumption (from one-third to one-eighth that of direct current).

The question of power factor is negligible due to low power consumption. Vertical and overhead welding are as easily done as with the direct current. Time and again we have had experienced welders work with alternating current who imagined they were using direct current.

Theorizing will not solve the question. The facts are available and easily attainable.

C. B. Waters,
Chief Engr. the Arcwell Corporation.

Railroad Electrification Facts and Factors*

Some Reasons for the Adoption of Electric Motive Power and Advantages Obtained from Its Use

By A. J. Manson

IN the series of articles commencing with this issue we are going to cover the application of the electric locomotive to steam railroads. The electric locomotive is no longer an experiment. Although its use on steam railroads in the beginning was more or less compulsory to overcome the smoke nuisance, it has proven itself reliable. Moreover it has shown itself superior to the steam locomotive not only in maintenance costs, in more flexibility of control and in availability for service, but in many other points as well, as we will show.

During the past few years the steam locomotive has advanced rapidly due to the introduction of economizers, superheaters, etc. The electric locomotive has more than kept pace with the rapid advance of the steam locomotive, however, and today we have single electric locomotives designed with axle loads of 65,000 lb. and with continuous capacity ratings of 4,000 and more horsepower.

For the past ten years the railroad expansion has not kept pace with the industrial growth, due to the various rate rulings and legislation cutting down the surplus. When the railroad situation is settled with many of the restrictions removed or lessened, there will be considerable activity in electrification, and before many years the railroads will be one of the greatest users of eectricity.

Now is the time for the steam railroad man to become acquainted with the application of electricity to the railroads for transportation purposes. It is not necessary that he be an electrical expert, but he should keep in touch with the electrical development as it relates to railroading. He should also become acquainted with electric locomotive construction and the electrical details so that he may intelligently pass upon the many recommendations which will come before him.

We finished in our January, 1918, issue a series of articles on "Calculations for Heavy Electric Traction." These articles dealt with the theory of electric traction; they covered train resistance, tractive effort, characteristic curves of railway motors, the speed-time curve, and finally the working out of a model electrification problem.

It is intended in this series to consider the application of the electric locomotive to the steam railroad; how it compares with the steam locomotive; its advantages; its construction, and the design and construction of its various parts. In addition the different electrification systems will be considered, so that the railroad man will have in these articles, together with the preceding series, sufficient information to intelligently analyze an electrification proposition which may be presented by a consulting engineer or an electrical manufacturer.

Before considering the mechanical and electrical construction of the electric locomotive, let us get a general perspective view of its application to railroad work; what advantages are gained by its use; its comparison with the steam locomotive as regards speed, tractive effort, horsepower ratings, and operation.

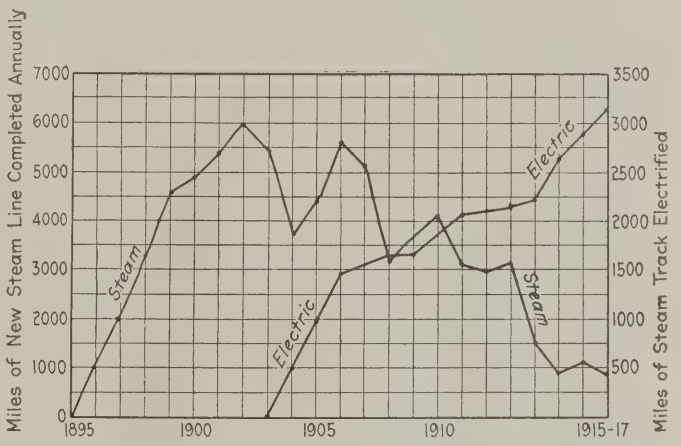
Terminals

The application of the electric locomotive to railroad work was first in terminal service. It was not a question of economies but a question of eliminating the nuisance and discomfort to the passengers and others of steam power. While at first the benefits, which were available, were not appreciated, it was not long before the many advantages of electric operation were realized, and now there is no other consideration for terminal operation.

Tunnels

Tunnels usually form the throat of railroad systems. Delays are necessarily incurred while waiting for the smoke to clear, and the inability to see signals forms a serious obstacle to free operation of freight trains with steam engines in long tunnels.

In addition to the dangers of operation and delays incurred, there are very disagreeable features as regards passenger traffic. These difficulties have long been recognized by the steam railroad officials. The advantages of electric operation in services of this class have been realized in several instances. Take, for instance,



Curve Showing the Trend Toward Railroad Electrification

the Hoosac Tunnel of the Boston & Maine, built in 1875. This was always an obstruction feature to the traffic of this road until its electrification in 1911. The delays caused by the smoke and gases made this tunnel the "limited section of the division." Under steam operation the entire tunnel was a block five miles long, as no train was permitted to enter while a passenger train was passing through. Maintenance costs were greatly reduced in this tunnel by the change to electric service. The old troubles of the rock and brickwork being shattered by the engine exhaust, telephone and signal lines being corroded by acid gases, and bad failures caused by

*The first of a series of articles in which the author will analyze the various parts of electric locomotives and electrified sections of steam railroads.

condensing steam have all disappeared. Track gangs can now work with safety and despatch in making repairs, while formerly only two hours of effective work in a day's shift was possible.

Among the first to realize the advantages of electrification for tunnel operation were the officials of the Grand Trunk Railway System. In 1908 they inaugurated electric service in the tunnel which connects the towns of Port Huron, Michigan, with Farnia, Ontario, by passing under the St. Clair River. The grades in the tunnel approaches, and the inclined portions of the tunnel are all 2%, necessitating high tractive effort to operate the freight trains. These conditions required, prior to electrification, special anthracite coal burning locomotives in order to reduce the smoke to a minimum. The maximum tractive effort of these steam locomotives limited the weight of train to about 760 tons and the speed up the grades was very slow. Being a single tube tunnel operated on the zone system of train despatching, the increase in traffic prevented efficient operation. Electrification not only eliminated the smoke and bad gases, but increased the capacity of the tunnel about 100%.

Freight Haulage

A new place has recently opened up for the electric locomotive, namely, hauling of freight over the heavy grades of the mountain divisions. The railroads derive practically 70% of the total revenue from the transportation of freight. Economies gained in this service will have a large bearing on the total net revenue.

Switching

Greater operating economies have been obtained by the use of electric switch locomotives than in any other class of service. Only one-half the number of electric locomotives are required, and the saving in coal as determined by actual test runs is demonstrated to be 66% of the amount used by the steam engines. Stand-by losses are eliminated; full capacity power is available in freezing weather and, moreover, they are available for service at all times.

Advantages

The electric locomotive has demonstrated two things conclusively, namely,—1st—complete reliability under all conditions of service, and 2nd—its low maintenance cost as compared with the steam locomotive. The maintenance of electric locomotives will average about 65% of that of steam locomotives of equal weight. This is apparent when we consider that at least one-half of the costs of repairs of the steam locomotive is expended on the boilers.

In general the electric locomotive has characteristics which are especially advantageous to railroad operation, namely:

1. Track capacity is increased in certain instances by 100%.

Stops for coal and water are eliminated, resulting in increased schedule speed.

2. Flexibility—which permits two or more units to be coupled together and operated by a single crew.

3. Symmetrical wheel arrangement—which permits of operation in either direction.

4. Availability for service—on account of no boiler or grate to clean, no water to take, no fire to light or bank. Under steam operation only 30% to 40% of the total hours are spent on the road, whereas with the electric locomotive over 90% of each 24 hours may be given in service. Greater mileages can be made between "shoppings."

5. Simplicity of operation.—All the electrical apparatus is so arranged that by the movement of small handles power is connected to the motors and the locomotive is brought up to speed.

6. Its ability to maintain a rated speed and tonnage capacity irrespective of cold weather.—The excessive radiation of heat while disastrous to the steam engine is of benefit to the electric locomotive, as more electric power can be passed through the motors without overheating, resulting in an increase of horsepower.

7. Operation—is from the head end where the engineer's vision is unobstructed and the best possible view of the track is obtained.

There is no class of machinery today that can be designed so exactly to meet given conditions as electrical machinery. This is pointed out by the reliability and freedom from failure of the electrified service in and about the City of New York. Here are located the electrified operating terminals of the two greatest railroad systems of the world, the train service on both of which, statistics show, is far less subject to interruptions and delays since operated by electricity than under the best results ever obtained by steam.

There is no longer a question of whether electricity can do the work of broadening, extending and improving the very admirable performance of the modern steam locomotive. This has been amply demonstrated.

The trend is towards electrification not alone due to the many inherent advantages of the electric locomotives, but to other important reasons. The rise in the cost of fuel has increased the operating costs greatly. Electric power can be produced at a low cost due to the development in hydro-electric and steam generating plants. The growth of traffic in the United States will be greatly increased and increased facilities will be necessary for the movement of this traffic. The high cost of changing track conditions will make it necessary to increase the service over the present tracks, and this can be done with electric operation.

In our next article we will make a comparison between the electric and steam locomotives as to horsepower rating, tractive effort and speed.

"Economy is near to the keystone of character and success. A boy that is taught to save his money will rarely be a bad man or a failure; the man who saves will rise in his trade or profession steadily; this is inevitable."—*Gladstone.*

In the United States Court at Toledo, Ohio, on December 16, a fine of $5,000 was imposed on the Kanawha & Michigan Railroad Company for giving rebates to Kelly's Creek Colliery Company, and one of $1,000 on the Colliery Company for accepting the rebates. At the same time the Toledo & Ohio Central Railroad Company, which entered a plea of guilty, was fined $1,000 for failing, for 39 days, to give the consignee notice of the arrival of a carload of coal at Toledo. These suits were based on transactions which took place more than a year ago.

The Interchangeability of Induction Motors

Alterations in Windings Adapt Motors to Use on Circuits of Different Frequency and Phase

By Gordon Fox

WE will first consider in this article the possibilities for adapting induction motors for use upon circuits of frequencies other than those for which the motors were designed. Since the two common commercial frequencies are 60 cycle and 25 cycle, we may well confine our study to how motors designed and rated for one of these frequencies can be adapted for use on the other.

Frequency has a bearing upon several factors of induction motor performance. First, it affects the speed of the revolving field. The synchronous speed of an induction motor is determined, as already set forth, by the expression $\frac{f \times 60 \times 2}{\text{no. poles}}$. It is here seen that the speed depends directly upon the frequency and varies proportionately with it. A 60-cycle motor connected to a 25-cycle circuit will operate at a little less than half speed. Conversely a 25-cycle motor will run at more than twice rated speed upon a 60-cycle circuit. It will be evident that before operating a 25-cycle motor on a 60-cycle circuit, the peripheral speed of the motor should be checked as mentioned in a previous article. It will also be seen that, if it is desired to use a motor on a different frequency but at the original speed, it will be necessary at the same time to change the number of poles. This may best be followed through by considering the operation in two steps, first with respect to the frequency change and second with reference to a change in speed with the new frequency.

The counter voltage of an induction motor depends directly upon the circuit frequency and is proportional to it. The counter voltage is induced by the changing flux and the rate of change is greater the higher the frequency. The counter voltage of each conductor in the winding of a motor on a 60-cycle circuit will be 2.4 times its counter voltage on a 25-cycle circuit, other conditions remaining the same. Since the impressed voltage is almost identical with the counter voltage it follows that, if the winding is not changed, a motor should be operated on 60 cycles at 2.4 times the voltage for 25-cycle operation. In actual practice 60-cycle motors are operated on 25-cycle circuits of half voltage and vice versa. The excess voltage on the lower frequency tends to run up the iron losses and increase the heating, but as a reduction of frequency is accompanied by a diminishing of the core losses, this tendency is largely offset. If we should connect a 60-cycle motor to a 25-cycle circuit of the voltage at which the motor is rated for 60 cycles, an excessive magnetizing current would flow and under these conditions the motor would overheat, the iron being the hottest part.

If we should connect a 25-cycle motor to a 60-cycle circuit of rated voltage the magnetizing current would be light and the flux density low. The motor would operate, but its pull out torque would be considerably less than normal. It might be advantageous to use the motor in this way if it is to be operated only at reduced capacity, as the low magnetizing current will afford a comparatively high power factor and efficiency. Ordinarily, however, it is desired to secure the full output of which a motor is capable, which implies that the flux density in the iron and the current density in the copper will be maintained at approximately the same values under all conditions.

Two facts have been brought out in previous discussion; first, that the speed of a motor is proportional to the frequency of the circuit on which it is operated, the number of poles in the winding being unchanged; second, that a given frame produces a given torque if worked to the same degree. From these two facts it follows that when a motor is used on a 60-cycle circuit at increased speed, the horsepower of the motor is increased in proportion to the increase in speed. This fact may be substantiated if it is recalled that, if the winding is unchanged, the motor must be operated at a higher voltage for 60 cycles than for 25 cycles. The current capacity of the winding is unchanged, as the internal circuits are not changed. The KVA input of which the motor is capable is therefore advanced in proportion to the increase in voltage, which in turn should be proportional to the increase in frequency and speed. If the number of poles in the winding were changed so that the speeds were the same on 60 cycles and 25 cycles, the horsepower rating would remain approximately the same for both frequencies. When a 60-cycle motor is operated on a 25-cycle circuit of half voltage the speed is less than half its original value, but the voltage being somewhat above normal, the torque is greater than normal and the horse power capacity is nearly maintained. On the other hand, when a 25-cycle motor is operated on a 60-cycle circuit of double voltage the speed is more than doubled, but the torque is not fully maintained, as the new voltage is less than normal. The horse power, proportional to product of torque and speed, remains about normal.

Induction motors are operated upon single phase, two-phase and three-phase circuits. Two-phase and three-phase induction motors of the same rating are practically identical except as to windings and perhaps as to number of slots in the stacking. Occasions arise when it is desired to operate one or more two phase motors upon a three phase circuit, and vice versa. Where an entire plant having motors of one type is to be connected to power lines of different phase or where an isolated plant uses central station service of different phase for break down service, the most practical procedure is to install transformers, Scott connected, either with a 1 to 1 voltage ratio or combining change of voltage and change of phase. For individual motors the installation of such

additional transforming equipment would rarely be feasible.

There are several methods for adapting induction motors for changes in number of phases. The coils may be regrouped for a differing phase arrangement, the winding may be Scott connected or rewinding may be resorted to. Reconnection of existing coils is brought about by opening all the end connections and dividing up the coils in new groups for the new number of phases. In some cases the total number of coils may be evenly divided between phases, in other cases it may be necessary to omit one or more coils to get equal division with the change. In determining the proper connection, in a change from two-phase to three-phase, for instance, the case may be resolved into a condition where we have a given number of coils of predetermined

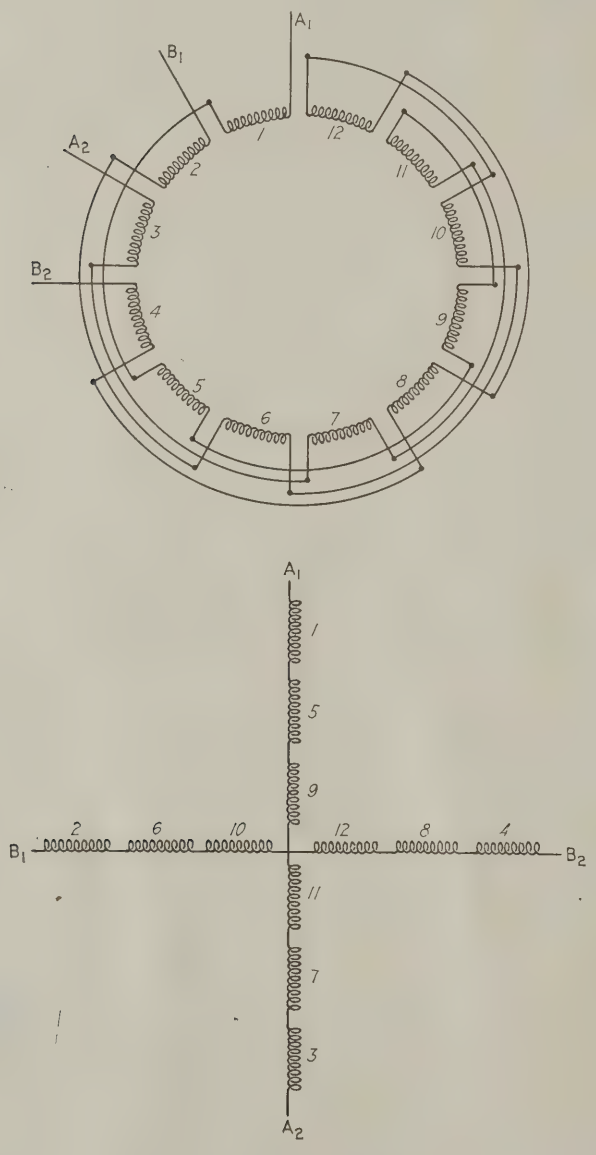


Fig. 1—Two Phase, 6 Pole Series Winding—108 Coils, 9 Coils Per Pole, Per Phase

design already inserted in the stator slots, with all end connections opened. It is desired to reconnect these coils to fit the desired specifications as to speed and voltage. In the ordinary case the speed is not changed in changing phases so that the pole pitch and coil throw are not affected and the chord factor retains the same value. It is thus only necessary to determine the voltage per coil by analysis of the original winding and to so combine and connect the coils in the new arrangement as to secure the desired voltage. Difficulty will likely be encountered in securing a combination to give the desired voltage, particularly if the voltage of the three-phase motor is to be the same as the two-phase rating

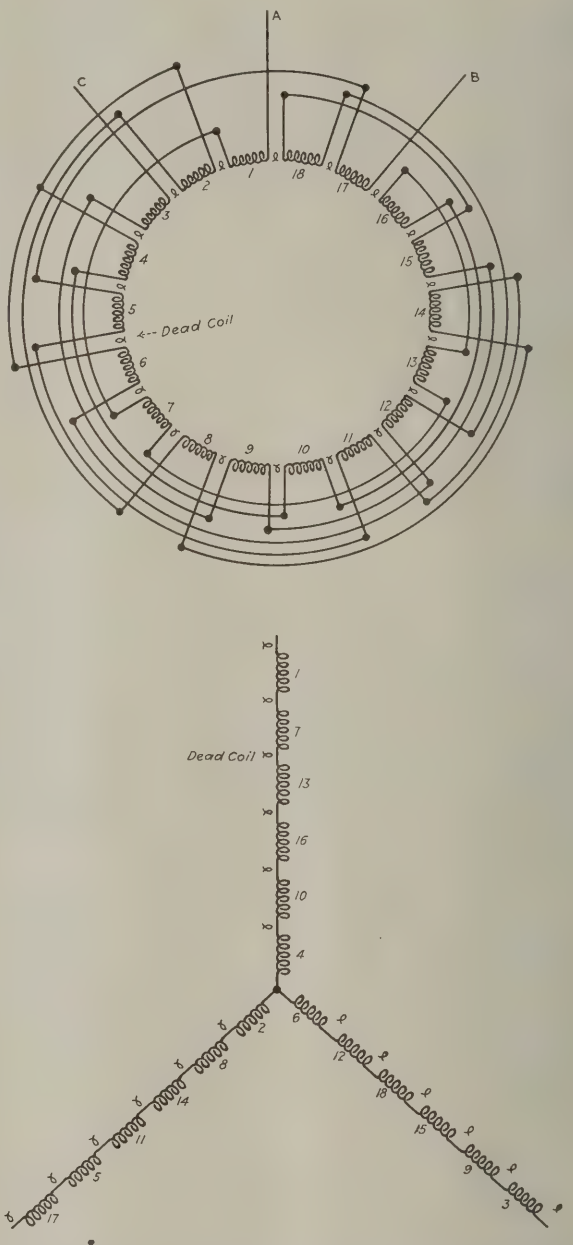


Fig. 2—Three Phase, 6 Pole, Series Star Winding, 18 Dead Coils, 5 Coils Per Pole Per Phase. Same Winding as Fig. 1 Reconnected

and vice versa. A two-phase motor having all coils per phase in series has about 25 per cent more turns than are required for a three-phase series star connection with all coils in series. On the other hand, there are not enough turns for a three-phase delta combination. To reconnect a two-phase motor having 1 circuit per phase, to a three-phase star winding for the same voltage, it will be necessary to cut out about 1/5 of the coils, dead ending them. This method will give satisfactory operation but it is necessary to reduce the horsepower rating. If a change over were made in this motor without cutting out any coils the motor would operate on

three-phase as on under voltage and would be seriously lacking in torque.

If a three-phase motor, series star connected, be changed over for two-phase service at the same speed and voltage, it will be found that there are insufficient turns. We will follow through the computation for reconnecting a three-phase—440 volt—36 coil—single star

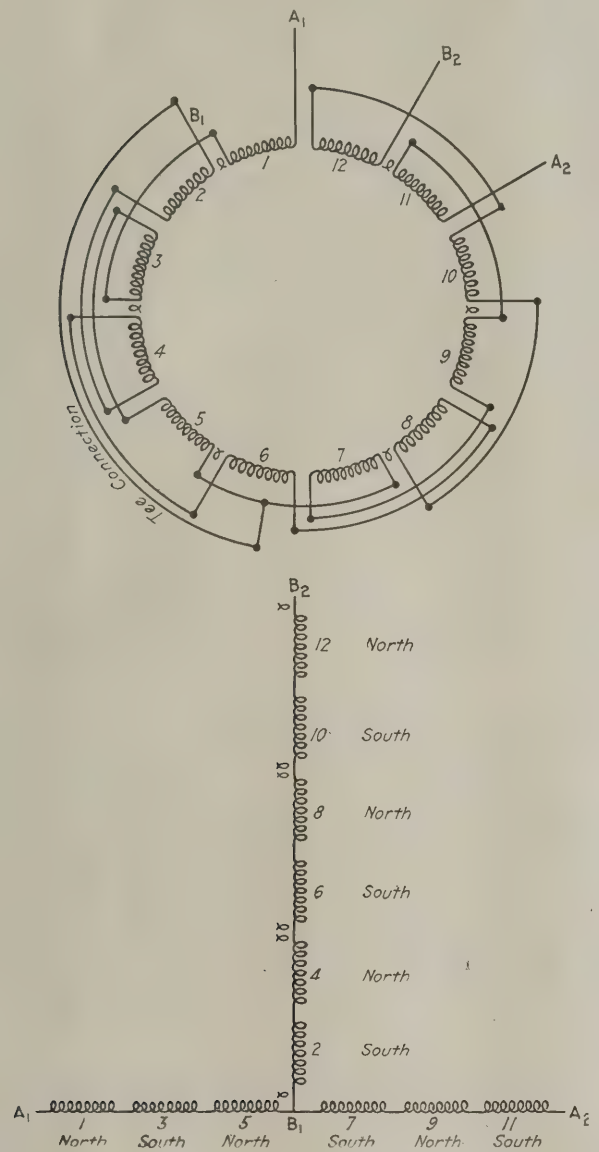


Fig. 3—Two Phase, 6 Pole Series Winding With 96 Coils Reconnected for 3 Phase By Scott Connection

connected motor to operate upon two-phase, 440 volt lines. When operating three-phase this motor had 12 coils per phase in series. The voltage per phase from line to neutral was $\frac{440}{1.73} = 254$ volts. The voltage per coil was therefore $\frac{254}{12} = 21.1$ volts. Reconnecting for two-phase we would have 18 coils in series per phase. Placing this winding upon a 440-volt two-phase circuit we will have about $\frac{440}{18}$ or 24.4 volts per coil, an excess of 3 3 volts or 15 per cent. This increase in voltage per coil will cause higher saturation of the iron, will enlarge the pull out torque, cause greater magnetizing current and lower efficiency and power factor. In general it is not advisable to operate motors on an overvoltage exceeding 10 per cent. Moreover, in two-phase motors having more coils per pole per phase, each group spans a greater arc and the individual coil voltages are further out of phase with each other, than for a three-phase winding, thus decreasing their vector sum. For this reason the excess of 15 per cent above mentioned would more likely be 20 per cent or more. It is thus evident that a series star connected three-phase winding cannot well be connected for two-phase service at the same speed and voltage.

It may be worked out in similar manner that a single

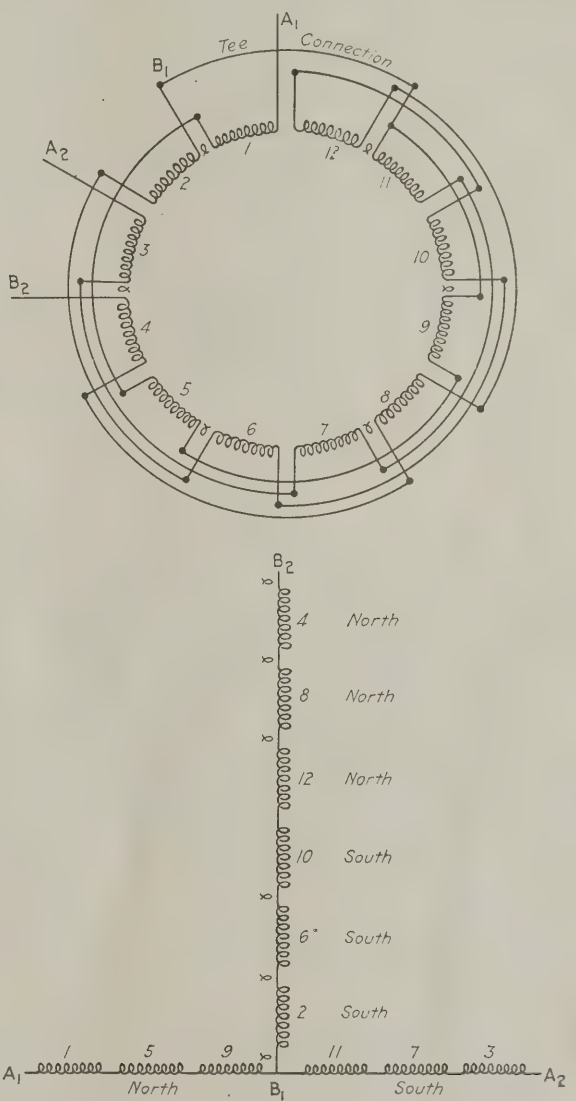


Fig. 4—Same as Fig. 3, Except Pole Groups Are Connected Alternately

circuit delta three-phase winding, if reconnected for two-phase service at the same speed and voltage, will have too many turns. This excess being nearly 40 per cent, it is not feasible to cut out enough coils to suit the winding to the circuit.

From the facts above given it will be evident that it is seldom feasible to reconnect a winding in this manner for a change from two-phase to three-phase, or vice

versa, where the voltage and speed are to remain the same. The change from two-phase to three-phase can the more often be accomplished by cutting out part of the winding, but at the expense of the horsepower capacity. Where the change in phase is accompanied by a change in voltage it may be possible to work the old winding in very nicely under the new conditions. If a change in speed is brought about in connection with the change in phase the element of change in counter voltage per turn in proportion to change in speed and the element of chord factor must be considered in figuring the voltage per coil, per coil group, per circuit and per phase. It may be stated that a two-phase motor and a three-phase motor of the same horsepower and speed will be the same size, and, in changing from one phase rating to the other a change in horsepower rating need only be made if the winding constants demand the change from the standpoint of heating. If a change in speed is made simultaneously with a change in phase, by changing the number of poles, the horsepower rating will be changed approximately in proportion to the speed, as in any other case. It should be noted that when coil grouping is modified as in any of the above connections the phase insulated coils no longer fall in the proper positions and relocation becomes necessary.

It is possible to adapt the Scott connection to the winding of an induction motor in much the same way as it is used with transformers. Induction motor windings are similar to transformer windings in many features. This method can be applied only to the use of two-phase motors on a three-phase circuit and it is feasible only

Phases	Circuits ...	Connection	Phases	3	3	3	3	3	3	3	3	2	2	2	2
			Circuits	1	2	3	4	1	2	3	4	1	2	3	4
			Connection	Y	Y	Y	Y	Δ	Δ	Δ	Δ				
3	1	Y	Figures to right show per cent voltage obtained by changing connection from that shown in left column to that shown in top column.	100	50	33	25	58	29	19	15	81	41	27	20
3	2	Y		200	100	67	50	116	58	39	29	162	81	54	40
3	3	Y		300	150	100	75	173	87	58	43	243	122	81	60
3	4	Y		400	200	133	100	232	116	77	58	324	163	108	80
3	1	Δ		173	86	58	43	100	50	33	25	140	70	47	35
3	2	Δ		346	173	115	87	200	100	67	50	280	140	94	70
3	3	Δ		519	259	173	130	300	150	100	75	420	210	141	105
3	4	Δ		692	346	231	173	400	200	133	100	560	280	188	140
2	1			125	63	42	31	72	37	24	18	100	50	33	25
2	2			250	125	84	63	144	73	49	37	200	100	67	50
2	3			375	188	125	94	216	111	73	55	300	150	100	75
2	4			500	250	167	125	288	148	97	73	400	200	133	100

Fig. 5—Table Showing Voltage Relations for Connection Changes, All Coils Being Used In Each Case, Frequency and Number of Poles Remaining the Same—Where These Are Changed Separate Calculations Must Be Made To Correct Accordingly.

when it is possible to cut out 10 to 15 per cent of the coils in one phase in order to secure the proper voltage triangle. If the voltage of one leg cannot be brought within the limits of 85 to 90 per cent of the other leg there will be too much unbalancing of phase voltages resulting in excessive local current. The necessity of cutting out a portion of the coils in one phase nearly precludes the use of this method where there are two or more circuits in parallel per phase. In the case of two circuits in parallel it is necessary to cut out 10-15 per cent of the coils in each circuit or 20-30 per cent of the entire winding for one phase. When the Scott connection is employed with a single circuit winding it is preferable to have the alternate pole arrangement shown in Fig. 4 rather than the adjacent pole connection as shown in Fig. 3. With the latter arrangement a slight eccentricity of the rotor might cause considerable inequality in the two branches of the base of the T, leading to local current and heating.

It will be evident from the above discussion that only in certain cases is it possible or feasible to regroup the coils of a motor for change in phase rating or to employ the Scott connection. In the majority of cases it will be necessary to supply a different set of coils and rewind the motor. In a still greater number of cases it is desirable to do this, although perhaps not entirely necessary. A set of coils does not represent a very large investment and it is better to replace a set of coils than to operate a motor in an unreliable or inefficient manner.

In closing this series of articles a table may well be included, showing the effect upon voltage of changes in three-phase and two-phase connections from one combination to another, either with the same number of phases or with a change in the number of phases. The table gives percentage values only. To translate to actual voltage values is a simple matter. Taking an example, a three-phase single circuit star winding for 440 volts will be suitable for 25 per cent of 440 volts or 110 volts if connected as a four-circuit star. If connected two-phase with three circuits per phase it will be suited for 27 per cent of 440 volts or 119 volts and could be operated satisfactorily on a two-phase 110 volt system. The table involves changes in voltage and phase only and does not apply directly where changes of speed or frequency are involved.

Hundreds of Tons of High Explosives, including T. N. T., the property of the French and Italian governments, has been towed out to sea from South Amboy, N. J., and dumped overboard 35 miles from Scotland Neck lightship. This was done by order of the Railroad Administration, in order to get the dangerous stuff out of the hands of the railroads. Two hundred and twenty-eight carloads had been stored at Wilmington, Del., for some time, awaiting disposition, and the residents of that city had become nervous for fear of disaster. Some of the material was removed to interior points.

Out of the War Necessity there came a new application of efficiency in dealing with national affairs. As we now face another transitional period—the period of demobilization and reconstruction—we must as a nation prepare to meet its problems in the same intelligent manner in which we dealt with mobilization. We shall need federal administrative agencies to plan industrial return from a war to a peace basis, to direct the order and the progress of the transition. The way in which we meet this problem will determine our progress in the years to come. Great economic advantage awaits the nation that can quickly enter the world's markets with the products of normal commerce. The nation that succeeds will be the nation that wisely directs return to peace production and that avoids friction between labor and capital. Friction can be minimized by providing such standards of working conditions as will insure understanding and co-operation between all persons concerned in the processes of production.—*Grant Hamilton, Director-General of the Working Conditions Service, Department of Labor.*

Light as an Aid to the Movement of Materials*

Proper Illumination Expedites the Handling of Freight at Transfer Platforms and Piers

THE war has placed exacting demands on industry and the reconstruction period will require great quantities of manufactured products. How can industry proceed if, with the plants producing huge outputs, the products cannot be moved to the places where required? The factor of transportation is of parallel importance to output.

It can easily be shown and has been demonstrated, to our sorrow, that a weakening of this important link in our system seriously impairs the entire industrial organization. If for one reason or another a terminal becomes congested, this is reflected along the whole line to the producer. Embargoes are put on and the manufacturers are forced to let up on their output. Each plant depends on others for parts and raw materials. It is, therefore, evident that anything which will help our transportation problem is a factor in our industrial program.

Speeding of shipment by good lighting is increased through the following direct causes:

(*a*) greater actual speed of trucking, etc.

(*b*) markings more easily read.

The indirect effects are

(*c*) less mis-sent shipments

(*d*) reduction of spoilage and thefts

(*e*) improved relations with the public.

These are not theoretical statements, but are borne out in practice.

(A) If a pier or freight station is dimly lighted, many portions in deep shadow, truckers must proceed cautiously, watching out for objects lying about on the floor, for they lack the confidence which comes with clear vision. Accident reports reveal that one of the most common causes is stumbling or falling. With poor lighting this hazard is increased. Not only does an accident affect the injured worker, but it has a demoralizing effect on the entire force. Each workman becomes over-cautious and slows down his movements. Proper light, therefore, increases the speed of freight handling.

(B) In sorting freight or express packages or stowing them aboard ship, it is of course necessary to read and check the labels or markings. It is self-evident that with plenty of light less time will be spent on this step of the handling. In many stations there are only a few spots where there is enough illumination to read labels, and material actually has to be moved there to be sorted. Certainly this extra handling is not efficient.

(C) Conversation with express officials indicates that one of their serious troubles is mis-sent shipments. Inadequate illumination is an important contributing cause. The reading matter on waybills is often faint or blurred and many packages are badly addressed. The chances for error under poor light are great. Packages sent to the wrong place sometimes never return. Perishable freight is often entirely lost if mis-sent. Occasionally an entire factory is held up awaiting the arrival of goods, the delay in transportation being due to a mis-sent shipment. Beyond the delay and cost of locating mis-sent material, there follows a further load on the transportation system of sending to proper destination.

(D) Spoilage of goods is reduced if there are no dark corners in which packages of perishable material become hidden. Again, boxes that have been broken in shipment are readily caught and taken care of before a greater loss is sustained. Breakage is bound to be reduced, for employees will not throw articles about promiscuously if the place is well enough lighted so that they are likely to be seen. Theft is greatly reduced, as the sneak thief would not dare to pry open a bundle and remove part of the goods if the chances of detection were high.

(E) Modern business methods have made it important to please the public. Common carriers desire to have the most cordial relation with shippers. If consignments are delivered promptly in undamaged condition, if the mis-sent shipments are eliminated, then the transportation agents should have the good will of the people.

It is apparent that the effect of light colored surroundings in increasing the illumination is not fully realized. Ceilings and walls have been allowed to become almost black, reflecting practically no light. A little white paint will save a great deal on the lighting bill and allow increased utilization of daylight.

In an investigation of 58 large steamship piers in New York City, as regards the artificial lighting, data was obtained on the size of the pier, number and size of lighting units, spacing and height of lamps, height of ceiling, color of walls and ceilings, class of traffic, watts per square foot and general artificial lighting conditions.

The investigators were experienced illuminating engineers, competent to evaluate the resultant illumination. An analysis of the results showed that 6.2 per cent. had good illumination, 51.2 per cent. fair illumination and 42.6 per cent. illumination which was entirely inadequate and generally poor. The average watts per square foot of those piers electrically lighted was 0.16, with a maximum of 0.34 and a minimum of 0.05. Very much better illumination results would have been obtained in practically all the cases if the equipment had been well maintained and surroundings given an occasional coat of whitewash or other light paint. Three and six-tenths per cent. of the piers had white walls and ceilings, 9.1 per cent. light colored, 20 per cent. medium colored, 52.8 per cent. dark and 14.5 per cent. very dark, in fact almost black, surroundings.

The above data justifies the foregoing criticisms. Such conditions would not be tolerated for the handling of materials in ordinary manufacturing plants, and the surprising feature is that it has been possible to get along at all with such poor light.

A few representative installations of tungsten filament lamps are presented in Table A. The figures given above, of course, include many other installations.

A similar investigation of some of the larger railway

*Abstracted from a paper by A. L. Powell and R. E. Harrington, read before the Illuminating Engineering Society, New York, N. Y., December 12, 1918.

freight stations in the metropolitan district disclosed conditions as outlined in Table B.

General Requirements of Lighting

Enough light must be provided to read markings, labels and waybills without eyestrain, and to see one's way about.

If the first requirements are provided for, the safety element would naturally be taken care of. A minimum of ½ foot-candle seems desirable in all parts of the station or pier. With this intensity average print can be read for a short period with reasonable ease. The Illuminating Engineering Society's Code of Lighting for

TABLE A.—Data on Typical Piers.—Metropolitan District.

	Size lamps	Hanging Height	Spacing	Watts per sq. ft.	Color Ceiling	Color Walls	Reflector	Remarks
Case A	100 watt 4 light clusters	15 ft.	40x50	0.20	dark	dark	dome	Spacing too wide for hanging height. Inefficient lighting units. Illumination results fair.
Case B	250 watt	18 ft.	50x50	0.10	light	dark	dome	Spacing too wide for hanging height. Results generally poor.
Case C	250 watt	15 ft.	30x40	0.20	dark	dark	Radial Wave	Lighting results good.
Case D	400 watt	14 ft.	50x100	0.08	dark	dark	dome	Spacing too wide for hanging height. Wattage too low. Results poor.
Case E	100 and 150 watt	15 ft.	30x30	0.16	dark	dark	dome	Conditions generally fair.
Case F	250 watt	20 ft.	irregular	0.07	light	light	dome	Spacing too wide for hanging height. Wattage too low. Results poor.
Case G	100 and 200 watt	18 ft.	various	0.09	dark	dark	dome	Results poor.
Case H	100 and 200 watt	20 ft.	20x35	0.18	light	light	dome	Illumination generally satisfactory.
Case I	400 watt	25 ft.	80	0.06	white	dark	dome	Spacing too wide for hanging height. Wattage too low. Results poor.
Case J	400 watt	15 ft.	50	0.16	white	dark	dome	Spacing too wide for hanging height. Wattage fair. Results fair.
Case K	100 watt	15 ft.	various	0.04	dark	dark	dome	Entire system poor.
Case L	100 watt 4 light clusters	15 ft.	30x60	0.22	dark	dark	dome	Results fair, but spacing too wide.
Case M	150 watt	18 ft.	30x60	0.08	light	dark	dome	Spacing too wide for hanging height. Wattage too low. Results poor.
Case N	100 watt 4 light clusters	25 ft.	40x78	0.13	light	light	dome	Inefficient lighting unit. Spacing satisfactory. Lighting results fair.
Case O	250 watt	20 ft.	70x50	0.07	dark	dark	none	Conditions very bad.

TABLE B.—Data on Typical Freight Station—Metropolitan District.

	Size lamps	Hanging height, feet	Spacing	Watts per sq. ft.	Color Ceiling	Color Walls	Reflector.	Condition	Remarks
Case A	25 and 40 watt	12	12x17	0.15 ave.	dark	dark	flat	very dirty	Arrangement good. Intensity too low. Poorly maintained, reflector inefficient.
Case B	300 watt	14	22x50	0.27	light	medium	radial wave	good	Arrangement satisfactory, adequate intensity, well maintained, reflector suitable.
Case C	100 watt	12	22x35	0.13	light	light	dome	fair	Illumination adequate for the particular conditions of this freight station.
Case D	100 watt	12	25x40	0.10	dark	dark	dome	fair	Spacing slightly too great, otherwise acceptable with better maintenance.
Case E	25 and 40 watt	10	—	—	dark	dark	none	poor	No general lighting provided, these lamps serving merely as markers.
Case F	60-watt carbon	8	—	—	dark	dark	none	poor	Lamps inefficient, no reflector, arrangement poor.
Case G	100 and 200 watt	11	—	0.24 ave.	dark	dark	dome and none	very dirty	No regular arrangement, poorly maintained, effect generally unsatisfactory.
Case H	100 watt	10	20x20	0.25	dark	dark	dome	good	Well laid out, good reflectors, results would be better with painting.
Case I	100 watt	9	30x35	0.10	dark	light	dome	fair	Spacing too wide, hence intensity low, otherwise satisfactory.
Case J	25 and 40 watt 3 light cluster	10	30x35	0.10	light	light	dome	poor	Generally unsuited.

Factories, Mills and Other Work Places, which has been adopted as mandatory in a number of states, provides a minimum intensity of ¼ foot-candle for passageways, aisles, storage spaces, etc. This value takes care of the safety element alone and is not intended to represent the most economical intensity, the code itself recommending that a higher intensity be provided.

In most instances lamps should be hung as high as possible. Properly applied, this does not reduce the average intensity of illumination, in spite of the popular misconception to the contrary. Lamps well up toward the ceiling are not so likely to be broken. In this position they are handled less and reflectors do not become so

Fig. 1—Day view in a warehouse which has an excellent illumination system. The rooms are divided into bays by columns on centers 20 x 20 feet. Each bay is provided with two outlets. Sixty-watt tungsten filament gas-filled mazda lamps in deep bowl intensive aluminum finish reflectors are placed close to the 13-ft. ceiling. All wiring is done in conduit and rows of lights are controlled by snap switches, which are located in the boxes shown on the columns in the foreground.

dirty. Light sources hung low or in the line of view may blind one temporarily and cause him to stumble.

After the system is properly installed, it should not be neglected. It is most necessary to have a careful system of regular maintenance. This feature seems to be generally neglected in freight terminals. Any railroad man certainly knows that his roadbed would not be safe if it were not regularly inspected and kept in first-class condition. A pier would soon fall to pieces if the spiles were not renewed when broken or rotted. On the other hand, lighting equipment is allowed to fall to pieces, lamps to become broken, reflectors rusty and very little attention is paid. The output of light is decreased considerably, even with a small layer of dust or dirt, yet many installations are in operation where equipment has been neglected for years. Certainly the user is receiving but a very small percentage of the light he is paying for.

Choice of the Size of Lamp

As a general rule, the larger lamps are more efficient and cost less per unit of illumination than small lamps. The fewer the number of outlets, the less the cost of wiring and maintenance. On the other hand, in designing an installation a consideration of this feature alone may make the lighting practically worthless. For example, an area of 4,000 square feet is to be lighted. If ¼ watt per square foot is provided, 1,000 watts are needed. For ordinary ceiling heights, one 1,000-watt lamp would certainly not be the type to employ.

The size of the lamp is controlled primarily by the ceiling height. In other words, lamps hung 20 feet above the floor on 20-foot centers give the same results as lamps 10 feet above the floor on 10-foot centers. Oll other items being equal, mind this statement, a 400-watt lamp 20 feet high would be as effective as four 100-watt lamps 10 feet high.

Other items to consider are (*a*) Obstructions of various sorts. If material is piled high or if there is much piping, cross beams, etc., it is apparent that dense shadows would be cast by large lamps widely spaced, which could be avoided using small lamps spaced more closely together. (*b*)Character of ceiling, walls and general surroundings. If these are light in color, reflecting well, then considerable diffuse light is introduced in the illumination. This eliminates shadows and permits wider spacing. (*c*) Size of bay. The total area is usually divided into bays by posts or columns and for good appearance, as well as ease of construction, it is desirable to install outlets symmetrically with respect to the bays. This, of course, has a determining effect on the spacing and hence on the size of lamps. This practice is particularly important in warehouses where material is piled or stored in reference to the arrangement of posts.

Choice of a Reflector

The question of decorative appearance is not very important in the class of building under consideration. The object is to get the maximum light on the floor and hence on the material with the least expenditure of energy. An efficient reflector is essential.

In general, glass reflectors are not well suited for this type of interior on account of the likelihood of their being broken. Freight handlers are none too gentle in their methods and in carrying high pieces, lengths of pipes, etc., no particular pains will be taken to clear the reflector. An efficient steel reflector is generally the solution.

The dome type reflector gives a greater spread of light than the deep bowl, permitting wide spacing without intervening areas in darkness. This style also gives a higher output.

The dirty surroundings have been mentioned before and the surface of the reflector should be such that it can be easily cleaned. Porcelain enamel is virtually a layer of glass applied to the steel base and has all the advantages of glass. It is easy to clean, soap and water or even a wet rag will give the porcelain a bright, clean, surface, returning it to its original efficiency, even though it has become greasy or very dirty. It resists acid fumes, whereas other finishes are likely to deteriorate rapidly if exposed to certain vapors. Being heat resistant, it does not depreciate nor turn yellow with age. It has a high reflecting power.

Warehouses, Express and Freight Stations

The light should be quite evenly distributed, as labels and markings must be read anywhere about the floor, yet the demands in this respect are by no means as exacting as where close visual work must be carried on. The intensity should be highest near the doorway and down the main aisles, for here is found the densest traffic. To

attain an average intensity of at least 1 foot-candle and not have the minimum appreciably below ¼ foot-candle, specified by the industrial codes, from 0.15 to 0.25 watt per square foot of floor area is advisable. This figure presumes the use of high efficiency lamps and suitable reflectors and takes into account an average amount of acquired depreciation, which is rather high in the class of building under consideration.

The following general rules on maximum desirable spacing apply:

Ceiling 10 feet or less	16 feet
Ceiling 10 to 15 feet	20 feet
Ceiling above 15 feet	30 feet

Of course, these are subject to more or less variation, depending on the manner in which material is stored.

For long, narrow rooms (less than 30 feet or approximately one bay wide), one central row of outlets will serve the purpose well. Seventy-five-watt tungsten filament gas-filled (Mazda C) lamps in enameled dome reflectors on 15-foot centers would be a typical installation for a room with a 10-foot ceiling, whereas 100-watt units on 20-foot centers could be used if the ceiling were 15 feet.

If the room is wider, it is well to space outlets symmetrically in the bays. For example, a warehouse from 40 to 60 feet wide should have two rows of lighting units, while one over 60 feet will probably require three rows.

Fig. 2—Night view of a loading platform 220 feet long, lighted by five 300-watt tungsten filament gas-filled mazda c units. These lamps are enclosed in opalescent diffusing globes and are suspended close to the 16-foot ceiling. The intensity of illumination is high and the light colored surroundings reflect the light and cause it to be quite evenly distributed.

With ceilings averaging 15 feet, one outlet in the center of each 20-foot standard bay is excellent practice. Where material is piled almost to the ceiling, it is necessary to localize units with reference to the aisles, as pictured in Fig. 1.

For the loading platforms similar units and rules as to spacing apply. A particularly well lighted platform of this character is shown in Fig. 2. Where units are exposed to the elements, attention must be paid to the weather proof qualities.

To provide for the lighting of cars which are to be unloaded or loaded, socket receptacles should be installed on the pillars near the track side of the warehouse or station. In some cases these are installed along the track edge of the platform, slightly below the level of the car doors. This practice has certain advantages in that a shorter cord will suffice and the wiring does not interfere with trucking.

Extension cords with suitable sockets and lamps with wire guard should be available for use inside of the cars. The lamp guards can well have a hook arrangement so that the units may be hung from the ceiling rods in the car. A typical layout for a small freight or express shed with loading platform is given in Fig. 3.

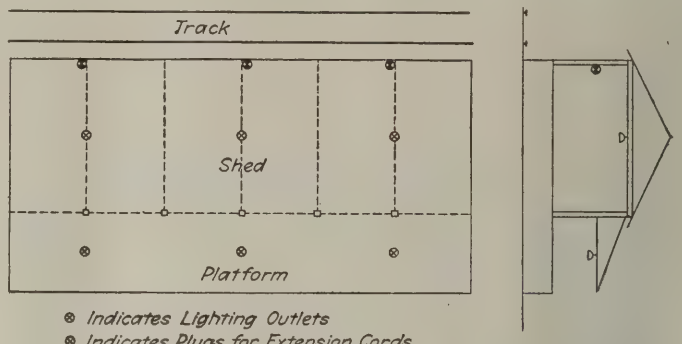


Fig. 3—Diagram Showing Lighting Layout of Typical Small Freight Shed

Transfer Platforms

Well lighted transfer platforms promote safety of trucking and facilitate the handling of freight and express between the freight houses and express platforms, and the cars on the outside tracks. Absence of light here is a contributing cause to the placing of freight in the wrong cars, for a great deal of this work is done at night.

These platforms are generally long and narrow, being merely the space between adjacent tracks. Some are covered and others uncovered. For the covered platforms, units should be located midway between supporting posts, or if the posts are very close together, in each second section. If the platforms are uncovered, a central row of posts should be provided which will support weather proof lighting units on simple bracket arms.

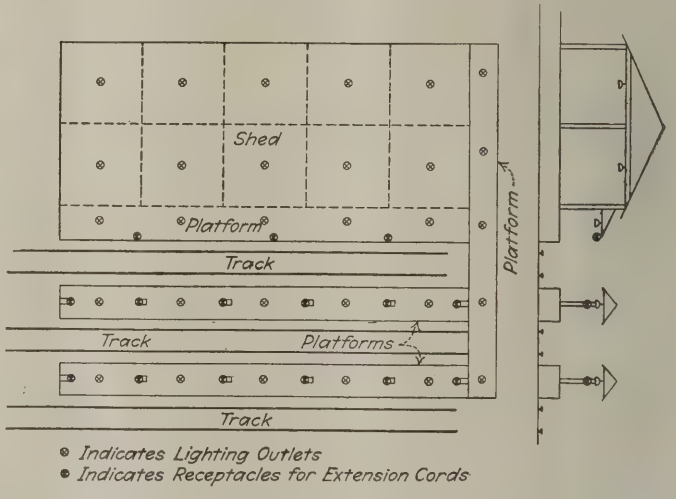


Fig. 4—Diagram of Lighting Layout of Typical Transfer Platform

For this work, a relatively flat reflector is most suitable, for not only must there be light on the ground, but also on vertical surfaces, as the freight checkers must compare

stub tickets given them in the warehouses, with similar tickets placed on the sides of the cars, for which the freight is intended.

It is difficult to state exactly what size of lamp should be used, as this depends largely on the spacing. Seventy-five-watt units on 15-foot centers, 100-watt units on 20-foot centers, 150-watt units on 30-foot centers should prove satisfactory. If, in the case of uncovered platforms, the poles are spaced as far apart as 40 feet, it is then well to use two units per pole, one on each side in the plane of the center line of the platform. This is necessary on account of the heavy shadow which would otherwise be cast by the pole. Whatever unit is used, it should be supported rigidly to prevent its swinging in the wind. It is also well to provide receptacles for extension cords in weather proof boxes on the pillars. A typical series of loading platforms is illustrated in Fig. 4.

Fig. 5—Night view of the delivery platform of a large railroad pier. This is illuminated by 200-watt bowl frosted tungsten filament gas-filled mazda c lamps with dome shaped enamel steel reflectors, hung well out of reach. Certainly trucking and freight handling can be carried on with expediency under such illumination.

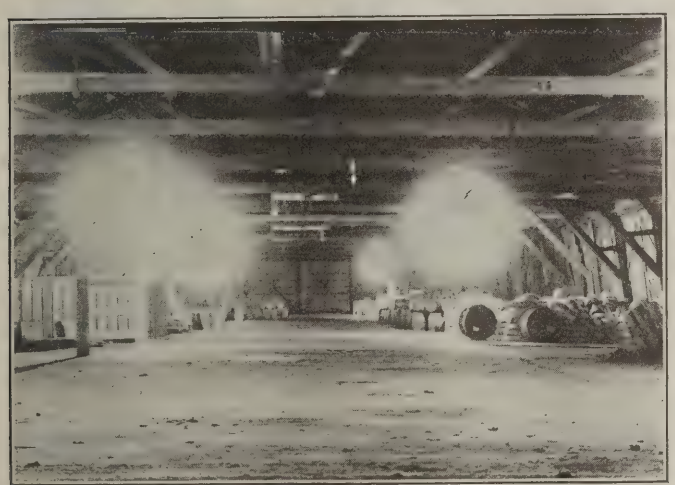


Fig. 6—Night view of a coastwise steamship pier illuminated by 500-watt tungsten filament gas-filled mazda lamps in dome type enameled reflectors hung close to the roof trusses. Slightly over one-quater watt per square foot thus supplied furnishes illumination adequately for safety and efficient freight handling.

For piers handling general freight and merchandise, the rules for spacing and size of lamps given under warehouses apply for the side bays or loading sections; approximately ¼ watt per square foot will give adequate lighting. For the trucking area or center bay, larger lamps can be used on wider spacings. A general figure of ⅛ watt per square foot will prove satisfactory. A typical loading platform or side bay well lighted in accordance with the rules laid down is shown in night view, Fig. 5.

Where the pier is relatively narrow with no line of demarkation between the loading areas and the general trucking space, as illustrated in Fig. 6, a symmetrical arrangement of outlets over the entire area best meets the conditions. The diagram, Fig. 7, however, shows an arrangement commonly encountered. For these particular dimensions, 150-watt lamps in enameled dome steel reflectors should be used, one each in the side bays, while 300-watt units of the same character on 50-foot centers furnish adequate light for the central or trucking space.

For piers devoted to the handling of fruit, the lighting requirements are considerably more exacting. A higher intensity is required and more even distribution. Fruit after being unloaded on the pier is generally sold at auction. The commission merchants visit the piers and inspect the fruit. It is quite important that the true condition of the fruit be shown to the prospective buyer. It is necessary that the color of the fruit is not distorted and a close approximation to white light is desirable for the artificial illumination. A case is on record where commission merchants have refused perfectly good fruit and left it to rot on the hands of the owners, because it appeared green under artificial light, the color composition of which was such as to distort materially the natural appearance. From 0.3 to 0.5 watts per square foot is desirable for a fruit pier.

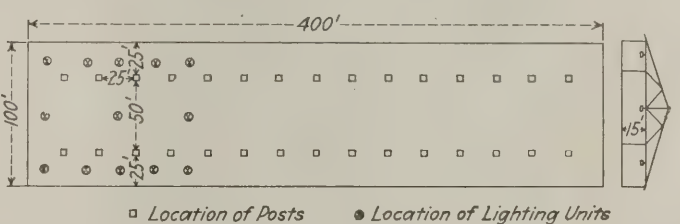


Fig. 7—Diagram Showing Typical Freight Pier Lighting Layout

Conclusion

It must be borne in mind that a difference exists between freight handling and ordinary manufacturing processes. In the latter, it is possible to install automatic machinery and so plan the work that undue congestion does not result. From the very nature of freight handling, practically all work is manual and rapidity of movement is essential to prevent delays and resultant tying up of traffic. The demand for proper artificial lighting is acute.

Conversation with agents in charge of poorly lighted stations and warehouses indicates that they realize that the cause of many mis-sent shipments is lack of proper lighting.

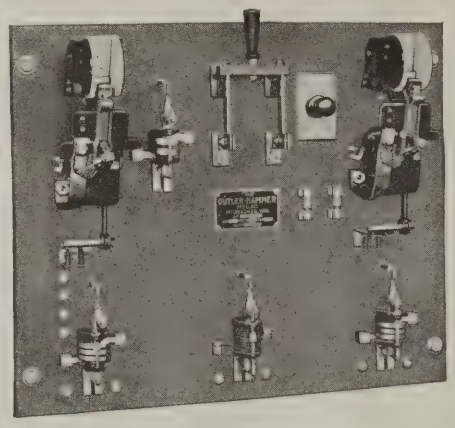
Accidents are increased with darkness. The cost of an accident in damages may be many times the cost of properly lighting a station, warehouse or pier for a long period.

SAFETY FIRST FOR CRANE AND OPERATOR

The average crane cab built a few years ago before the advent of safety first ideas, and even some cabs now manufactured, give practically no protection to the motors and actually present hazards to the operator. By simply removing the dangerous open switch-board and installing in its place a Crane Protective Panel mounted in a steel cabinet all the danger of the electrical shock will be removed and assured protection given to the motors and operator.

These panels take the place of the various circuit breakers, knife switches, fuses, etc., previously mounted in the crane cab—giving a complete switch-board on which is arranged all the necessary protective devices and safety features.

No-Voltage and Overload protection is provided for each motor supplied through the panel, a thing largely possible with the usual equipment. The control of the panel is obtained through a push-button station. The control circuit is so arranged that one clapper switch is closed when the "start" button is depressed and the other when the "start" button is released.



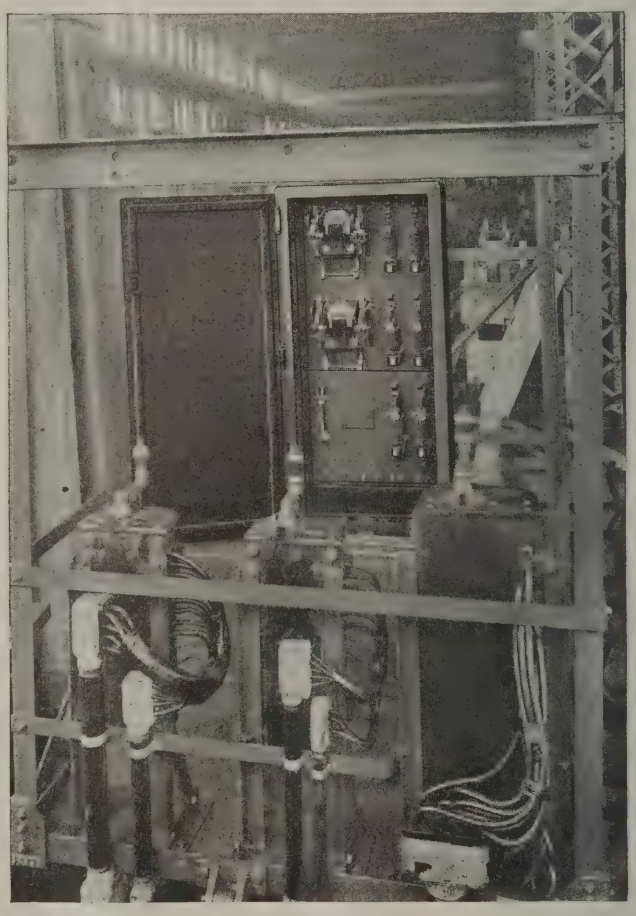
Standard direct current crane protective panel for use with manually controlled cranes

In case an overload or ground condition remains the first switch closed would be opened when the second switch is closed, thus obtaining the "non-closing on overload" feature.

To start the crane the operator merely depresses the "start" button for an instant before manipulating the motor controllers, this requiring far less time than closing numerous circuit breakers and fuses. To shut off the power from all circuits, he touches the "stop" button. If he wishes to inspect any motor, or leave the crane temporarily in an inoperative condition, he can withdraw the safety plug and take it with him. As a further preventative against starting the crane when it is stopped for any repairs both the electrician and the crane operator can be provided with separate locks, which when inserted in hinged clips of the main line knife switch, prevent it from being closed.

The direct current crane panel shown in the smaller illustration has all of the following apparatus: One double pole single throw knife switch with means for locking the switch open by inserting one of two padlocks (one for the operator and one for the electrician); one main circuit, automatic reset overload relay on one side of the line; one automatic reset overload relay for each crane motor and connected on the opposite side of the line to the main circuit relay; two magnetically operated main line clapper switches, one for each side of the line; one operator's safety plug which will open the control circuit when removed from the panel; and two enclosed fuses in the control circuit and terminal lugs for external connections to mains, motor heads, and control push-button stations.

The installation view shows a special alternating current protective panel for three polyphase motors. Each motor has two, hand-reset, time limit overload relays, one in each of two phases, to protect the motors against overload. The two double pole magnetic main line switches open all three phases; the connections being so



Special crane protective panel for cranes having 3 polyphase motors. Panel provides two inverse time-element overload relays for each motor.

arranged to give double safety, for should one switch become inoperative the other would open two phases and stop the motor. These two switches are controlled from a push button station placed near the operator. The single pole knife switch shown in the lower left hand corner of the panel is also connected in the control circuit and may be locked open with an ordinary padlock in order to prevent any accidental and unauthorized operation of the crane.

These protecting panels are made by the Cutler-Hammer Mfg. Co., of Milwaukee, for cranes having either alternating or direct current motors aggregating 50 to 400 H. P.

Practical Inspection Methods for Shop Motors

Unique Card System Prevents Any Motor from Being Overlooked, Regardless of Its Location

By L. L. Richart

THE present demand for greater and still greater transportation by our railways and for continued increased production from our essential industries means that every part of the equipment used, whether on the railroads or in the shops, must do its work with the greatest efficiency. Delays of any kind must be avoided. At the present time practically all of the large railroad shops as well as other industries are electrically driven and the shutting down of a single motor for even a short time to make minor repairs is a costly experience. It is a fact, however, that many serious delays can be avoided and production kept at a maximum, if a proper system of motor inspection is put into use.

MOTOR INSPECTION

Motor No.....

Month .....

1	J.N.B.	△	17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16					

Fig. 1—One of these Cards is Placed at Each Motor and Upon It the Inspection Record is Kept

The Motor Inspector

First of all, efficient motor maintenance means prevention of trouble rather than repairs. One or more motor inspectors should be employed in every electrically driven establishment, depending upon the number of motors in service. The man selected as a motor inspector should be a keen observer and possess a generous amount of common sense and good judgment. When motors are doing heavy duty and in operation practically night and day they should be inspected at the very least once a day.

Human nature is a factor that must be reckoned with in successful motor maintenance. It very often happens that some of the most important operations in the roundhouse or shop are driven by a motor that is not readily accessible and as a result this motor does not receive proper care and attention, which eventually results in a shutdown. The motor inspector knows that there is no positive way of knowing whether he did or did not examine this motor carefully each day and for this very reason he is in a position to take an unfair advantage. In order to overcome this human weakness and secure some tangible evidence from the inspector that he has done his work properly, a card and punch system has been used which gives excellent results. This system requires a card, shown in Fig. 1, for each motor each month. This card may be printed on medium-weight white pasteboard, about 3 in. by 5 in. Each motor should be provided with a suitable card holder made from sheet iron which is conveniently placed so that the card will be kept clean. Seven or more common conductors' ticket punches, each having a different punch, should also be provided. Before the inspector starts on his trip he reports to the person in charge, who keeps a motor inspection card which may be designated as the key card. Before a punch is turned over to the inspector the key card is punched opposite the proper date.

After he has inspected each motor the inspector removes the card from its holder on the motor and signs his initial or his last name opposite the proper date and then punches in the square space provided directly after his name and replaces the card in the holder.

Careful attention and good judgment should be used in the selection of the different punches each day so that the same punch marks are not used in regular sequence. It should be noted that the same punch is to be used for the entire inspection for one day. In order to make this inspection effective it is necessary that the person in charge compare each motor card frequently with his key card and to see that motor inspection cards are always left in their proper places.

The above described system has proved to be very satisfactory in keeping the inspector on the job, but it will not keep the motors going.

The Inspector's Duty

The inspector's duty is to prevent trouble and to do this he should satisfy himself that each of the following questions can be answered in a satisfactory manner:

(1) Is the motor excessively hot in any part? Hot or burning insulation can generally be detected by the odor. If he can hold his hand for 30 seconds on the bearing linings or the field or stator windings, no danger need be expected from these parts. If in doubt, putty should be put on the part of the motor in question and the mercury end of a thermometer put in the putty and

allowed to remain until the temperature becomes constant. Experience proves that as long as the temperature does not exceed 65 deg. C. no damage will result. The inspector should also note if the current of air caused by the fanning action of the armature or revolving elements is excessive.

(2) Are the oil wells full of clean motor oil and the oil rings carrying plenty of oil to the bearings? The use of a small flashlight will assist the inspector in getting this information quickly and accurately. Experience has proved in a general way the viscosity of a good motor oil should be between 150 and 200. If oil is added to the motor while in operation the indicators on the side of the oil wells should not be quite full. If they are entirely full, when the motor is stopped the bearings will overflow and probably some of this excess oil will get on the motor windings.

(3) What is the cause of that unusual noise or hum? It may be excessive end play or a loose brush on a commutator or slip-ring, or in the case of an induction motor, it may be running single phase due to a blown fuse or broken wire. It may be that the bearings are worn and the revolving element is rubbing. A careful inspection of the air gap by the eye will probably answer. If not the motor should be stopped and gaged with the proper air gap gage, which is generally furnished with the motor by the manufacturer.

(4) Is the speed of this motor about normal? Low speed is very often a good indication of trouble. This answer can generally be determined by observation of the shafting or machinery driven by the motor.

(5) Is the motor clean and free from dirt and oil? Oil on a motor in any part except the bearings is to be avoided, since it injures the insulation, causing grounds and short circuits. Moreover, oil on the motor or beneath it may have come from one of the bearings, which will, of course, be low in oil as a result.

This system has been put to a practical test in two different shops where motor maintenance was a difficult problem and in each case motor trouble was reduced so low that practically no delays were traceable to lack of motive power.

STATISTICS OF THE RAILROAD YEAR, 1918

Nearly twice as much mileage of railroad was abandoned in 1918 in the United States as the new mileage built. There were 1,183 miles of railroad abandoned in 1918 and of this 446 miles was actually taken up. In Canada, 200 miles of railroad was abandoned, and perhaps the most remarkable thing about this was that the greater part of it was a single stretch of line.

The new railroad line built in 1918 in the United States totals 721 miles. This is 212 miles less than the previous low record of 933 miles made in 1915, and is the least built in any year of which the Railway Electrical Engineer has record; this record extending back to and including the year, 1893. In Canada, a total of 135 miles of new line was built in 1918 as compared with 207 miles in 1917. Mexico reports 10 miles of new line completed in 1918.

The greater part of the mileage built in the United States was branch lines or extension of lines to coal mines. It was the necessity for reaching new coal mines which may be said to have been generally speaking, the only incentive strong enough to induce the building of new railroad mileage.

The railroads of the United States have installed automatic block signals during the past year on about 1800 miles of road and have built or rebuilt interlocking apparatus at 140 plants, the interlocking machines aggregating 3,204 levers; 1,982 mechanical and 1,222 electric or electro-pneumatic. These improvements have cost something like seven millions, the expenditures in this department to November 1, as reported by the Railroad Administration, having amounted to $5,965,544. The increase in the total mileage of road block signaled cannot be stated with accuracy, as a good deal of the new signaling takes the place of the manual system and some of our information is incomplete; but a rough estimate would increase the total of *automatic* signalling from 34,799 miles of road one year ago to 36,500 miles at the present time. The total mileage of both automatic and non-automatic block signals, which was 98,954 miles of road a year ago has increased but little during the past year. The total length of road which has been equipped in 1918 with the manual block signal system was only 125 miles.

The length of road on which automatic block signals are now under construction is reported as 1515 miles, and plans for 1919 include 1298 miles; both of these figures are not greatly different from those made up one year ago. Many roads, however, both this year and last, have given us no information as to their plans for the future. The total of the budgets of the signal departments for 1918, as recorded at Washington, was $12,787,402, or more than double the amount mentioned above as expended in the first ten months and most of these unexpended appropriations will, no doubt, be carried out as early as practicable in 1919. The interlocking now under construction aggregates 3246 levers (1604 mechanical and 1642 electric), which is about the same as a year ago; and that proposed for 1919 totals 2196 levers (932 mechanical and 1264 electric).

There was only one important receivership, that of the Denver & Rio Grande with 2610 miles, but the railroad itself was not placed under the jurisdiction of a court officer but, like solvent roads and like roads which were being operated by their receivers, it was placed in the hands of a federal manager appointed by the Railroad Administration, who supervised its operation during the year.

The freight cars built in 1918 in the United States and Canada totalled 124,708. This compared with 151,401 freight cars built in 1917. The passenger cars built in 1918 totalled only 1573 and compare with 2000 built in 1917. The locomotives built in 1918 in the United States and Canada, including equipment built in this country for Europe and especially for France, was 6475. Of these, 4930 locomotives were standard gage locomotives; the remainder being narrow gage contractors' equipment and narrow gage gasoline and steam equipment for France. In 1917, the total of all locomotives, including narrow gage, was 5446. The 1918 figures were exceeded both in 1907 and in 1906; in 1907 there was 7362 locomotives built and, in 1906, 6952.

Elements of Practical Electricity

A Series of Articles Prepared for the Benefit of the New Men in the Railroad Electrical Field

VIII—Types of Direct Current Generators

IT has been shown in just what manner electricity is generated in a loop of wire or series of loops rotating in a magnetic field. In the simple type of experimental generator, which has been illustrated and explained, it has been shown that permanent magnets were used in every case. In general, however, permanent magnets are not suitable for use in the construction of direct-current generators. Field magnets are invariably

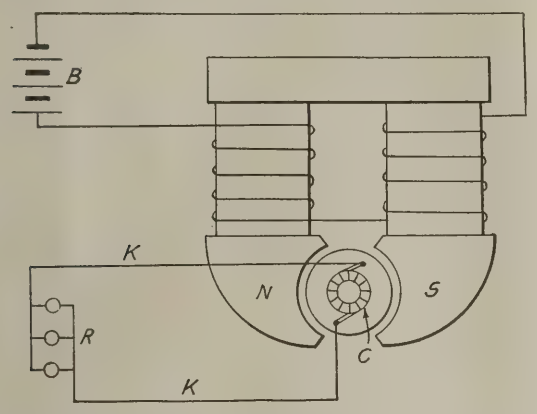


Fig. 1—A Separately Excited Generator. The Field Magnets Are Energized By Current From a Battery

excited or energized by current flowing through many turns of wire surrounding them. In other words, the magnetic field of a generator is produced by an electro-magnet.

Types of Generators

A direct current generator may be separately excited or self-excited, depending entirely upon whether the current which magnetizes the field of the machine is supplied from some external source, such as a storage battery, or whether this magnetizing current is developed by the armature of the machine itself.

A conventional diagram showing the wiring of a separately excited two-pole direct current generator is shown in Fig 1. The battery *B* shown at the left, furnishes current to the windings on the magnet cores, producing a north and a south magnetic pole between which an armature rotates. From brushes resting upon the commutator *C*, of the armature, current is led through an external circuit, *K K*, to the resistance *R*, which in this case is represented by three lamps in parallel.

With such an arrangement as this it is clearly evident that the voltage developed in the revolving armature is dependent upon the flow of current in the field coils, and in turn this current is supplied from an external source or battery. Machines of this particular type are very infrequent, since in order to energize the field coils a separate source of current must be continually maintained.

By far the most common method of energizing or exciting the field coils of a direct current generator is to supply the necessary current from the armature of the machine itself. This is the only practical way in which to magnetize the field poles of a generator. The connection of a simple two-pole machine arranged for self-excitation is shown in Fig. 2. In this particular case it will be seen that the current is developed in the armature, flows through the winding on the field magnet, through the external circuit, *K K*, and resistance *R*, back to the armature. This type of machine is absolutely independent of any external source of current to magnetize its field cores.

To those who are not familiar with the operation of direct current generators it may be somewhat puzzling to understand how an armature revolving between two unmagnetized poles is able to generate the necessary current to excite them. As a matter of fact if the field poles of the machine were absolutely without any magnetism it would be impossible to develop even the smallest current in the armature rotating between the field poles. This, however, is not the condition that is met in practice. Even though the magnets are dependent for their magnetism upon the current flowing in the windings it is very rare indeed that these field poles do not retain a very small amount of magnetism. This magnetism, which resides in the field poles of a generator when there is no current flowing in the field winding, is known as *residual*

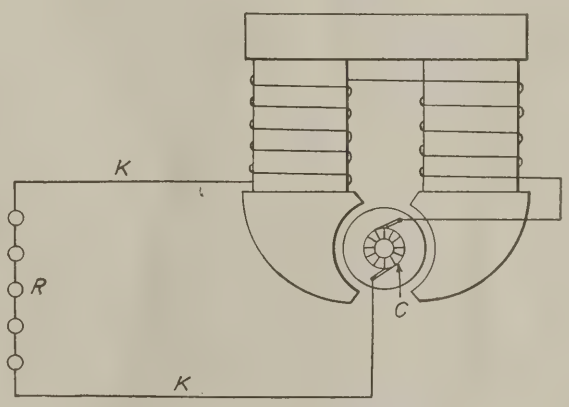


Fig. 2—A Self Excited Generator. In this Machine the Field Magnets Are Energized By Current Developed in the Generator Itself

magnetism. However small it may be, when the armature is rotated rapidly between the field poles its conductors cut the weak field produced by the residual magnetism and an e. m. f. of very small magnitude is developed. This e. m. f. sends a weak current through the windings on the field magnet and the current in turn increases the magnetism. The rotating armature cuts more lines of force produced by the increased field, develops a greater e. m. f., sends more current through the field windings and this cycle repeats and continues

until the iron of the field circuit has become entirely saturated with the magnetism. When this point has been reached there will no longer be an increase in the magnetic field of the machine and the e. m. f. developed in the rotating armature will reach a constant value.

Direct current generators may be divided into three distinct classes. The names of these several classes are derived from the manner in which the connections are made between the field windings and the armature. The three groups are—the *series* generator, the *shunt* generator and the *compound* generator. These three types meet practically every requirement that can be made on a direct current machine. Each type has its own particular characteristics and is best suited for certain kinds

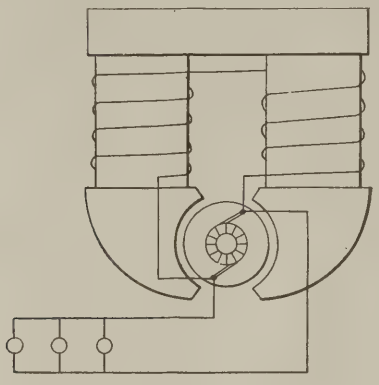


Fig. 3—A Shunt Wound Generator. The Circuit for Exciting the Fields Is Independent of the External or Load Circuit

of work for which the other types would be unsatisfactory.

The wiring scheme of a series generator is shown in Fig. 2. Here it will be seen that the current generated in the armature must traverse the windings of the field magnets and the resistance in the external circuit in series. If the circuit is broken at any point the current will, of course, immediately cease to flow, the field poles will lose their magnetism and the generator will no longer develop an e. m. f. Direct current series generators are not nearly so extensively used as they were formerly. Comparatively very few of them are being constructed today for the reason that the particular need for which they were best suited has almost entirely disappeared due to a greatly extended use of alternating current apparatus. Direct current series generators are suitable for developing a very high e. m. f. and for this reason were extensively used in long street lighting circuits. However, they have been largely replaced by alternating current generators which are well suited for the same purpose and which have many advantages that the direct current series generators do not possess.

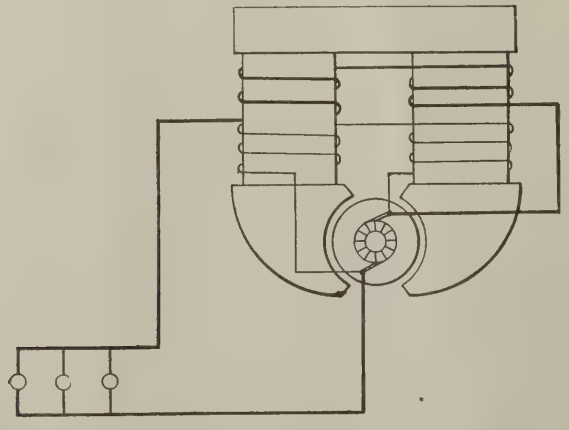


Fig. 4—A Short Shunt Compound Wound Generator

The second type, known as the shunt generator, is much more commonly found. This type is shown in

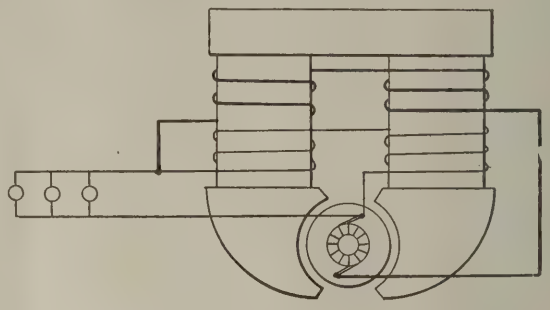


Fig. 5—A Long Shunt Compound Wound Generator

Fig. 3. It is a self-excited machine, but an examination of the sketch will show that the circuit which magnetizes the field cores is entirely separate from the external or load circuit of the machine. In fact the two circuits are in parallel, both being tapped off of the brushes of the commutator. In a machine of this type it is entirely possible for the armature to develop an e. m. f. regardless of whether any current is flowing in the external circuit or not.

The compound wound generator is in reality a combination of both the series machine and the shunt ma-

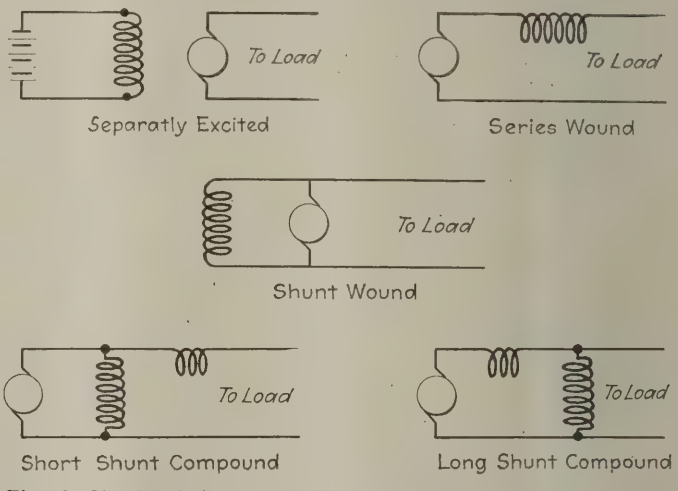


Fig. 6—Simplified Diagrams Showing More Clearly Connections Between the Fields and Armature

chine. Some of the current which is supplied to the external circuit traverses the windings of the field magnet before reaching the external resistance or load, but in addition to these magnetizing effects a shunt field circuit is also maintained. A diagram of the winding connections for a compound wound generator is shown in Fig. 4. When the connections of such a machine are made, as shown in this figure, the generator is known as a *short* shunt compound wound generator, as distinguished from the *long* shunt compound wound machine which is shown in Fig. 5. The names, short shunt and long shunt, are derived from the method of connecting the shunt field terminals. In Fig. 4, it will be seen that the shunt field which is composed of the smaller wire and indicated

in the sketch by the lighter lines is connected directly across the brushes of the machine in the same manner as in the case of the shunt wound generator. The series field, which is composed of a few turns of heavier wire, is connected in such a way that the current which flows to the external circuit or load must pass through the field windings and in so doing assist in the magnetization of the field cores.

The long shunt machine does not differ in practical

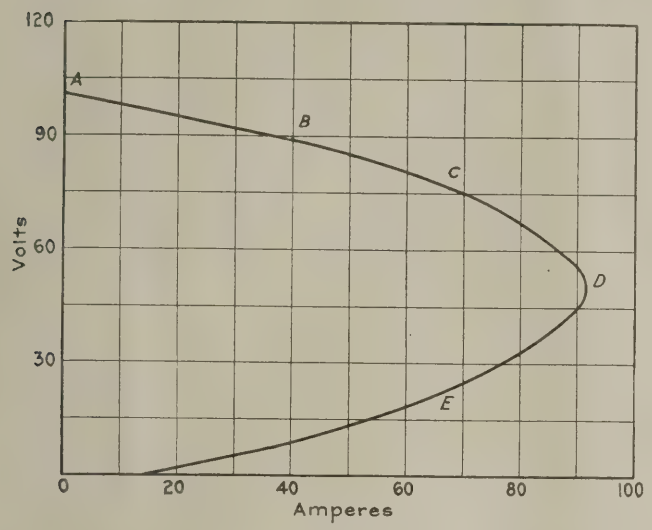


Fig. 7—External Characteristic of a Shunt Generator

operation but very little from the short shunt machine. One terminal of the shunt field is connected to one of the brushes as before, but the other terminal of this field is connected to the other brush only through the series field windings. In other words, the current which flows in the shunt field winding must flow through the series field windings as well.

Simplified diagrams of the several types of direct cur-

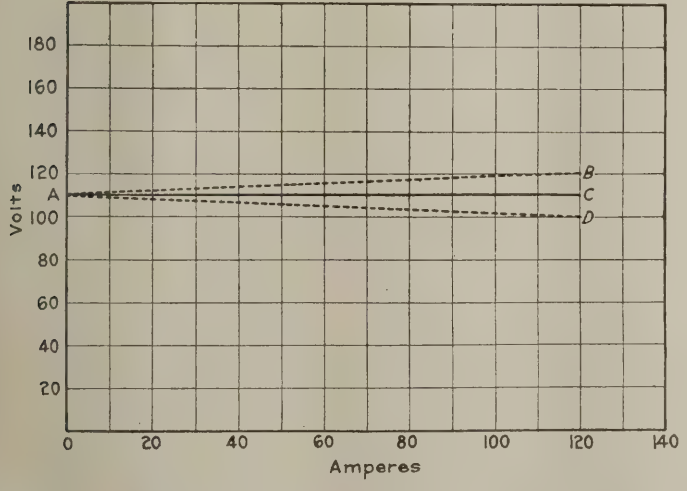


Fig. 8—Characteristics of a Compound Wound Generator

rent generators are shown in Fig. 6. Such diagrams as these are the ones which are most commonly used in electrical discussions. The diagrams are so simple in fact that they scarcely require any further comment. The difference in the connections of the short shunt and long shunt compound wound machines is particularly noticeable. It should not be supposed, however, that there is any particular advantage in connecting a machine as a short shunt machine or as a long shunt machine. Both methods are used and the performance of generators connected both ways are almost identical and the selection of the manner of making the connection is largely a matter of personal opinion.

Characteristic Curves

The performance of most electrical apparatus is best studied whenever it can be reduced to a graphical representation by the use of curves. This is true of direct current generators. The curves most commonly met with in the study of direct current generators are known

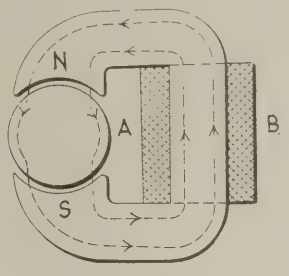


Fig. 9—Salient Pole Magnet With Single Magnetizing Coil

as external characteristics. They show the relation between the current and the voltage in the different parts of the machine while it is operating under different loads.

Characteristic curves have been developed for all three types of direct current generators but inasmuch as the series generator is so little used on the railroads, or indeed anywhere else, it is not believed advisable to take up any time or space in the discussion of the curves of this type of machine.

The shunt generator, however, is one which has a wide use and the characteristics of this machine are as peculiar as they are interesting. The heavy curved line, *A, B, C, D,* and *E* of Fig. 7, represents the external characteristic of a shunt generator. The vertical distance of any point in this curve above the horizontal line represents the volt-

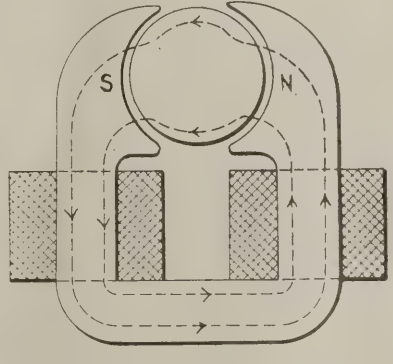


Fig. 10—Salient Pole Magnet Having Two Magnetizing Coils

age at the brushes of the machine when it is supplying current, the magnitude of which is indicated by the figures in the horizontal row at the bottom directly below the point chosen on the curve. In other words vertical distances represent brush voltage and horizontal distances represent current supplied to the external circuit. From this curve it will be seen that when the current in the external circuit is zero that the brush voltage is at its maximum which in this particular case is approximately

97 volts. If the generator is now connected to an external load and a current of 40 amperes is drawn from the machine it will be noticed that the voltage at the brushes falls to a value of approximately 89 volts. If the resistance of the external circuit is again reduced so that a current of 70 amperes flows from the machine the brush voltage will fall to about 75 volts. Continually reducing the resistance of the external circuit and thereby drawing more and more current from the generator, the brush voltage will fall lower and lower until the point *D*, is reached. This point is known as the *critical* point in the external characteristic of a shunt generator. Beyond this point the characteristic curve is seen to turn back in the direction of the origin or zero. This simply means that if the resistance in the external circuit is further reduced a condition is brought about which has the effect of short circuiting the windings of the shunt field. By referring to the diagram of the shunt wound generator in Fig. 6, it will be seen that the shunt field winding and the load circuit are connected in parallel across the brushes of the machine. This being the case it is quite obvious that if the resistance of the external circuit be made exceedingly low, practically all of the current developed in the armature will pass through this low resistance as it is the path which presents the least opposition. The shunt field winding which is deprived of its magnetizing current during this short circuiting process is not longer able to maintain the magnetizing force at the

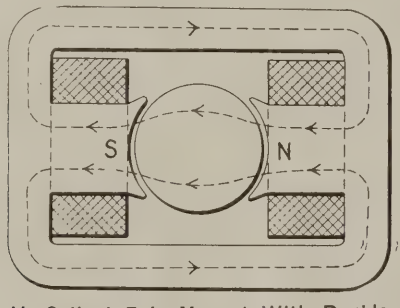


Fig. 11—Salient Pole Magnet With Double Yoke

field poles and consequently the voltage falls lower and lower until the field becomes entirely ineffective.

From the foregoing it will be seen that it is not practical to operate a shunt generator beyond the critical value. The practical operating portion of the characteristic is located between the points *B* and *C* and it is not wise to attempt to exceed these values for current.

The external characteristics of a compound wound machine depends very largely upon the windings in the series field. It will be remembered that the current which is supplied to the external circuit flows through the series winding and increases the magnetism of the field cores and hence raises the voltage. This rise in voltage which is occasioned by the current flowing in the series field is dependent upon two things, first, it depends upon the strength of the current flowing in the series windings and, second, upon the number of turns of wire about the field cores. A machine which has a comparatively large number of turns in its series field is said to be *over-compounded*, whereas one which has but a very few turns in the series field is said to be *under-compounded*. Between these two extremes it is possible to design a series field winding which has just sufficient number of turns to maintain the voltage of the machine at a constant value throughout its entire range of load. With an over-compounded machine the brush voltage will tend to rise with an excessive load, while with an under-compounded machine the voltage will fall with an excessive load in a manner somewhat similar to that indicated by the external characteristic of a shunt generator except that the drop in voltage is not nearly so great. The characteristics of the three classes of compound wound generators are shown in Fig. 8. These curves, *AB*, *AC* and *AD*, represent respectively the characteristics of an *over-compounded*, a *flat compounded* and an *under-compounded*

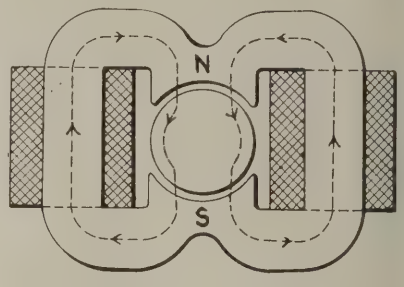


Fig. 12—Consequent Pole Magnet

machine. All three machines have an open circuit voltage of 110. The one whose characteristic is *AB* increases its terminal voltage by 10 volts when operating under full load. The machine whose characteristics is *AC* maintains practically the same voltage throughout its entire range of load, while the terminal voltage of the third machine is seen to drop about 10 volts when operating at its full load capacity.

Compound wound machines are frequently designed to give a rising voltage on increase of load. This is done in order that the voltage may be kept more nearly constant at some point where the power is consumed. This practice is especially true for machines which supply incandescent lighting circuits, or electric railway feeders where the load is inclined to fluctuate.

Types of Magnetic Circuits

Although the types of magnetic circuits used in the construction of direct current generators are many and

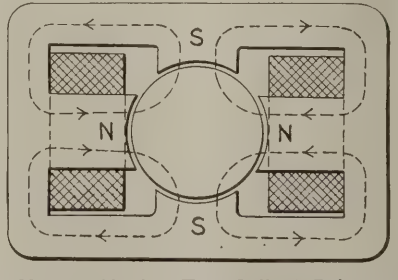


Fig. 13—Magnet Having Two Salient Poles and Two Consequent Poles

varied they may be divided into two general classes, namely, the *salient* pole type and the *consequent* pole type.

When a single source of magnetizing force is used to send lines of force through the magnetic circuit of which the air gaps and armature form a part, the magnetic circuit is said to be of the salient pole type. One of the simplest forms of this construction is shown in Fig. 9. This particular type is found in extensive use in the con-

struction of small dynamos, especially toy machines which are of low voltage. In this particular type the magnetizing force consists of a single coil, the cross-section *AB* of which is shown in the sketch. Magnetic circuits of the type shown in Fig. 9 may be so constructed as to stand in a vertical position, or in a horizontal position with the armature at the top and the magnetizing coil at the bottom. Both types are frequently observed.

Another type of the salient pole magnetic circuit is shown in Fig. 10. The magnetizing force in this case consists of two coils connected in series and is therefore considered as a single source of magnetizing force for which reason the magnetic circuit is classified as the salient pole type.

Another form of the salient pole type is illustrated in Fig. 11. Although the magnetic circuit differs considerably in appearance from the forms shown in Figs. 9 and 10, the magnetizing force is still derived from a single source. Two coils are used, one placed on either pole. That portion of the magnetic circuit which joins the two poles together is known as the yoke and this particular type of magnet is said to possess a double yoke.

The consequent pole magnet is fundamentally different from the salient pole type. Two magnetizing forces are required for each pair of poles. These forces are in opposition in the closed magnetic circuit and tend to send lines of force in opposite directions. These opposing lines of force meet and since it is impossible for them to pass each other and complete their circuits independently through the yoke of the machine they form poles at points on the yoke which are midway between the two magnetizing forces. An illustration of the consequent pole magnet type of the machine is shown in Fig. 12. As a result of the two magnetizing forces established by the two coils consequent poles are formed at *N* and *S*. In reality the consequent pole type of magnetic circuit is a combination of two salient pole types such as shown in Fig. 9.

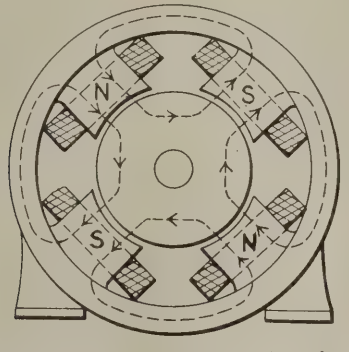


Fig. 14—Four Pole Magnet, Each Pole Salient

Another form of magnetic circuit which is not unfrequently met with is shown in Fig. 13. Two coils are used, one of which is placed upon each of two poles. These coils are connected so that the lines of force emanating from the poles upon which they are placed are in opposition to each other. In this particular sketch they are indicated as north poles. The lines of force tend to complete their circuits and in so doing establish the consequent poles, which in this case are south poles. A magnetic circuit is thus formed consisting of two salient poles and two consequent poles.

Perhaps the most common of all magnetic circuits is that shown in Fig. 14. This sketch illustrates a four-pole magnet, each pole of which is a salient pole. Machines constructed with this type of magnetic circuit are to be found everywhere. This particular type is known as a multi-pole magnet and has proved to be very popular among the manufacturers of electrical generators and machines. It may be found having almost any even number of salient poles.

It should not be supposed that the few examples of magnetic circuits which are here illustrated and described comprise the entire range of design. Many modifications of these types exist, particularly among the manufacturers of smaller generators and in machines designed for special purposes.

WITH THE CAR-LIGHTING ELECTRICIAN

By One Who Knows.

Mr. Car-lighting Electrician are you keeping up with the times or are you playing Rip-Van-Winkle? Are you familiar with the many car lighting equipments? I suppose you have heard of the Gesellschaft für Elektrische Zugbelenchtung System. Well! If you haven't don't worry and if you have, be an American made electrician and forget it because it is made in Germany. What I want to ask is, are you familiar with every system that is made in America? Now I hear a fellow say, "I never worked on any equipment other than the Gould and Safety, how can I be booked on other equipments?" I hear another fellow say: "What's the use of bothering with other equipment?" Well, let me tell you, Mr. Man, the big men in car-lighting today are men who have made a study of car-lighting equipments on every road in existence and if you desire to advance you will do likewise.

Next let me ask if you have the education to enable you to read and understand thoroughly an article describing some particular car-lighting equipment. Can you read a blue print? Can you read a graph? Do you understand the various electrical expressions used? In other words have you the electrical theory that a car-lighting electrician ought to have?

When you hear a fellow say that there is nothing to car-lighting, that car-lighting doesn't require any electrical theory, that car-lighting is work for those with weak minds and a strong back, don't be discouraged. You can rest assured that this fellow is not familiar with car-lighting and his experience, if any, is limited to wiping off battery covers, cleaning battery terminals, washing the lamp shades, taking voltage tests at some terminal, painting battery boxes, etc. Yes, it is true that you will find some electrical engineers (not engineers of car-lighting), who will read over the theory of an axle-lighting equipment and decide at once that it is all very simple and doesn't require much study and concentration. But let these same electrical engineers be placed to engineer car-lighting and note how suddenly their idea of car-lighting changes.

Are you still convinced that you are resting peacefully when you should be preparing yourself for a prosperous future? What's that? You say that you can't see anything ahead of you in car-lighting that is worth spending two evenings a week in school and a

night or two at home reading. That your boss studied and missed a lot of fun and he hasn't acquired enough to repay him. Young man, if you have reached that stage you're to be pitied, you're doing yourself an injustice. Your boss may have a small job but you'll never be qualified even for his place. *You have absolutely reached your limit* and you will always be paid for what you do, not for what you know, because if you were you'd starve to death. The unfortunate part of a tragedy like this is that usually a fellow with such ideas will influence possibly a whole gang to lag back, waste their time and eventually lose out. I say lose out, because some fine day a fellow is going to come along who has a little pep, who is going to study, and therefore is bound to advance. This chap is going to ride over you fellows just as sure as fate and then you will think as I do now, but unfortunately it will be too late.

Now suppose we look around a minute and see what we have in car-lighting. We have a generator or motor, a generator regulating device—a lighting circuit that is controlled by a lamp voltage regulator and a storage battery. Now you know as well as I do that a generator is a generator regardless of what size it may be. It may be a one K. W. Generator or a thousand K. W. Generator and yet they both have the same essential parts. Therefore if you are both theoretical and practical on car-lighting, why could you not apply this theory to a battery or a generator, or a lighting circuit or a voltage regulator that is designed for some use other than car-lighting? Why, Mr. Man, you have more of an opportunity in car-lighting to acquire valuable electrical knowledge and experience than any other line of the electrical trade that I know of.

In large manufacturing plants a fellow is usually experienced on one particular part of a generator or a battery, or a meter, but not so with car-lighting. No sir. In car-lighting you have an opportunity to study and operate a whole power plant and distribution system on each car. Take an office building, for example, one electrician looks after the lights and fans through the building, another electrician looks after the generator and switch board, another electrician looks after the elevators, etc., each fellow is experienced in his particular line of work but think of how narrow this fellow's experience will be in a few years in comparison to a car-lighting electrician who has two generators apart today, a battery apart tomorrow, a lamp circuit in trouble the following day and a regulator out of adjustment the next, and so on. But still with this excellent opportunity you will find that a large percentage of car-lighting electricians have little or no theory. Don't take my word for it, but in your gang tomorrow ask some fellow to figure the number of amperes a 50 Watt 30 Volt lamp will take—also ask him to figure the resistance of that same lamp. Ask every fellow in the gang and find out how many can solve this simple electrical problem. One fellow may say, "Pshaw! when I want to know anything like that I just ask the boss:" Well, suppose the boss should die. Wouldn't that be a terrible state of affairs? Why you might just as well die with him.

Now, you don't have to die, because the boss did, or you don't have to wait until some fellow comes along with some pep and gets ahead of you. First measure yourself from an educational standpoint and get some good electrical books just beyond the limits of your present education and when the day of advancement arrives you'll be qualified and will be repaid for the time you have spent in working up the details of car-lighting.

Don't be misled, Mr. Car-lighting Electrician, *there is* something to car-lighting and my advice to every car-lighting man, particularly those who have entered the car-lighting field within the past few years, is to study, and if possible attend night school. Also keep yourself well supplied with up to the minute information on car-lighting, by subscribing to the *Railway Electrical Engineer* or some other good magazine. Remember you have selected car-lighting as an occupation and it is your duty to keep up with its advancement. If you will keep on the top of car-lighting, then car-lighting will keep on the top for you!

ELECTRICITY HAS WON THE WAR

By Sidney Neu, Westinghouse Electric & Mfg. Co.

Electricity has played no unimportant part in the winning of the war. Only on the battlefield has the work of the electrical engineer not been apparent—poison gas, liquid fire, shrapnel, explosive shell, machine guns, rifle bullets, bayonets, and men that fought like demons, showed no sign of the presence of electricity. Yet were it not for electricity and man's control of its use, these forces of victory had not been.

Think back to the gunsmith of a century ago. Could he have armed an army of four million men in eighteen months? With four million men withdrawn from production, could any army have been equipped? Electrically driven machine tools made possible what human sweat and muscle never could have accomplished.

Unheard of tons of steel have been required, and those best able to judge have said that without electric drive to speed production in the mills we should have fallen short.

Uniforms were needed to clothe the men who fought. They could not go naked while weavers leisurely wove the cloth, cutters shaped it, and tailors sat cross-legged slowly stitching seams. Electricity was called on to do these things with speed, and the uniforms were made—breeches, shirts, leggings, shoes, underwear, hats, belts, millions of them.

Of these things, some were doubtless made by steam power unaided, but where production was the swiftest and therefore the most effective, electric drive was responsible.

The chemicals that speeded the shells on their way, that burst the shell to fragments, that made the very air untenable for the foe, owed their production in the tremendous quantities required to electricity. Electrochemical processes fashioned some, electric drive furnished the controllable mechanical power for making others.

The army and the nation needed food and electricity produced it. Fertilizers produced by electrochemical means made the earth productive, electric driven ma-

chines threshed much of the wheat, prepared the meat, operated the packing plants, ground the flour, entered everywhere into the production of food to make human labor less and to release more men to carry fear to the hearts of barbarians.

In its gentler aspects electricity appeared even on the field of battle, guiding armies, battalions, even individual shells. The airman by his wireless telephone and telegraph guided the gunner far to the rear who would otherwise have been blind. The commander watched through his wire and wireless network the progress of his fighting units miles away, kept them correlated into one vast machine that acted as a whole, not as a multitude of unrelated parts.

Billions of billions of electric sparks daily ignited the cylinder charges of motor trucks, lorries, airplanes, motor cars, motor cycles and the victorious tanks. Without electricity for ignition these engines would have been unheard of.

Electricity enabled the ships at sea with their precious freight of American manhood to keep each other in touch, to avoid the hidden dangers that menaced, to signal back as each arrived, "We're here, and safe!"

The ships themselves—did not electricity produce them? Their plates were rolled and shaped and machined in electrically driven machinery. Electric cranes transported their parts, electric compressors furnished the power behind the busy riveters.

Speed won the war when it was won and saved millions of human lives and untold additional human suffering—America's speed. The world marvels at America's speed and even America marvels. America was capable of this unheard of speed because America has made electricity its servant. Many men have been needed to accomplish what has been done in preparation, but at least twice and probably three times as many men would have been needed had not electricity been ready to help, and there were not that many men.

Electric light in battlefield searchlights patrolled the sky and no man's land, guarding against surprise. At home protective electric lighting dispensed with many human guards who thus could lend their hands to much-needed production. Within the busy plants men worked through the long hours of night as swiftly as by day, because electric illumination was at hand.

So short was the man power that even with electricity's help women were required to lend their aid in making ready our fighters' equipment. Without electricity women's help would have been but feeble. It is because electric drive tames rough forces and makes cumbersome machinery so simple to manipulate that it was possible for women to do what only men had done before. Work with machinery had been considered man's exclusive sphere because it had been rough work, heavy work. Electricity has made it such light work that it no longer fatigues the frailer sex.

Nor is this alone electricity's part in putting women at the lathe, the punch press and the planer. It has simplified the home so that she can be spared. We forget the duties that women formerly had in the home. She was spinner and weaver and tailor, she was laundress and housemaid, baker and cook, milkmaid and charwoman. Electrical machinery and electrical transportation have taken many of these duties out of the home. Those that are left, washing, ironing, sweeping, cooking and sewing, electricity has so lightened that women have been able to take their part in saving the world for those that dwell in it. Where many women were needed in the "good old days" to keep one household running smoothly, one alone now finds time to spare.

Trace back to its source any thing or factor that has helped to end the struggle, and electricity is found, not once but many times to have touched it and hastened it on to consummation. Truly, electricity has won the war, electricity guided by American brains, led on by American energy, crowned by American valor.

BATTERY CHARGING PLANT ON THE NEW HAVEN

The New York, New Haven & Hartford Railroad has recently purchased two charging switchboards—one for the New Haven yards and the other for the Readville shops together with a steam engine set, motor generator sets and power switchboards. The switchboards were developed sometime ago by the General Electric Company for Public Garage vehicle battery charging work but later modified to make them adaptable to the several phases of terminal charging of train lighting storage batteries.

At Readville the power switchboard, the motor generator set and the steam generator set are located in one building and the charging switchboard in another. At New Haven the power and charging switchboards are combined and located in the same room with the motor generator set. The charging systems are similar at both places, but the Readville equipment is three times the charging capacity of the New Haven equipment and also provides for discharging a maximum of four batteries simultaneously.

The illustration shows the interior of the power station at New Haven Yard placed in operation last May. The charging system is the so-called "constant current multiple"—better called the "series resistance or individual battery control" system, with common return. There are ten outlets, nine being located in the yard and one at the repair bench in the power house. Each outlet is connected on one side to the "common" wire from the negative bus bar, and on the other side to a wire leading to a plug switch on the distribution panel of the switchboard. Four 300 ampere-hour 16-cell lead type storage batteries may be charged simultaneously at their normal 8-hour rate or a smaller number at a higher rate.

The motor generator set consists of a 150 ampere, 75 volt flat compound wound generator direct connected to a three-phase, 60 cycle, 440 volt induction motor, both mounted on a unit cast iron subbase. The generator voltage is higher than required for charging 16-cell lead batteries under ordinary circumstances, as it is occasionally necessary to charge a 32-cell lead battery. This can be charged by placing it at the location nearest the power house, charging it alone, and over-exciting the generator. In this installation there is an additional advantage in having the generator voltage higher than required for charging 16-cell lead batteries, for the power supply is so fluctuating as to sometimes cause the batteries to "pump back" on the set when the generator voltage is near that required for the charge. When this occurs the reverse

current protective circuit breaker opens and interrupts progress of the charge; as the operator is obliged to spend part of his time in the yard this frequent interruption is a serious matter. The interruptions due to minor fluctuations may be overcome by carrying the generator voltage higher than normally required and cutting down the voltage on each individual battery by a little extra series resistance; then the set would have to slow down considerably before the batteries will "pump back" enough to trip out the generator reverse current circuit breaker.

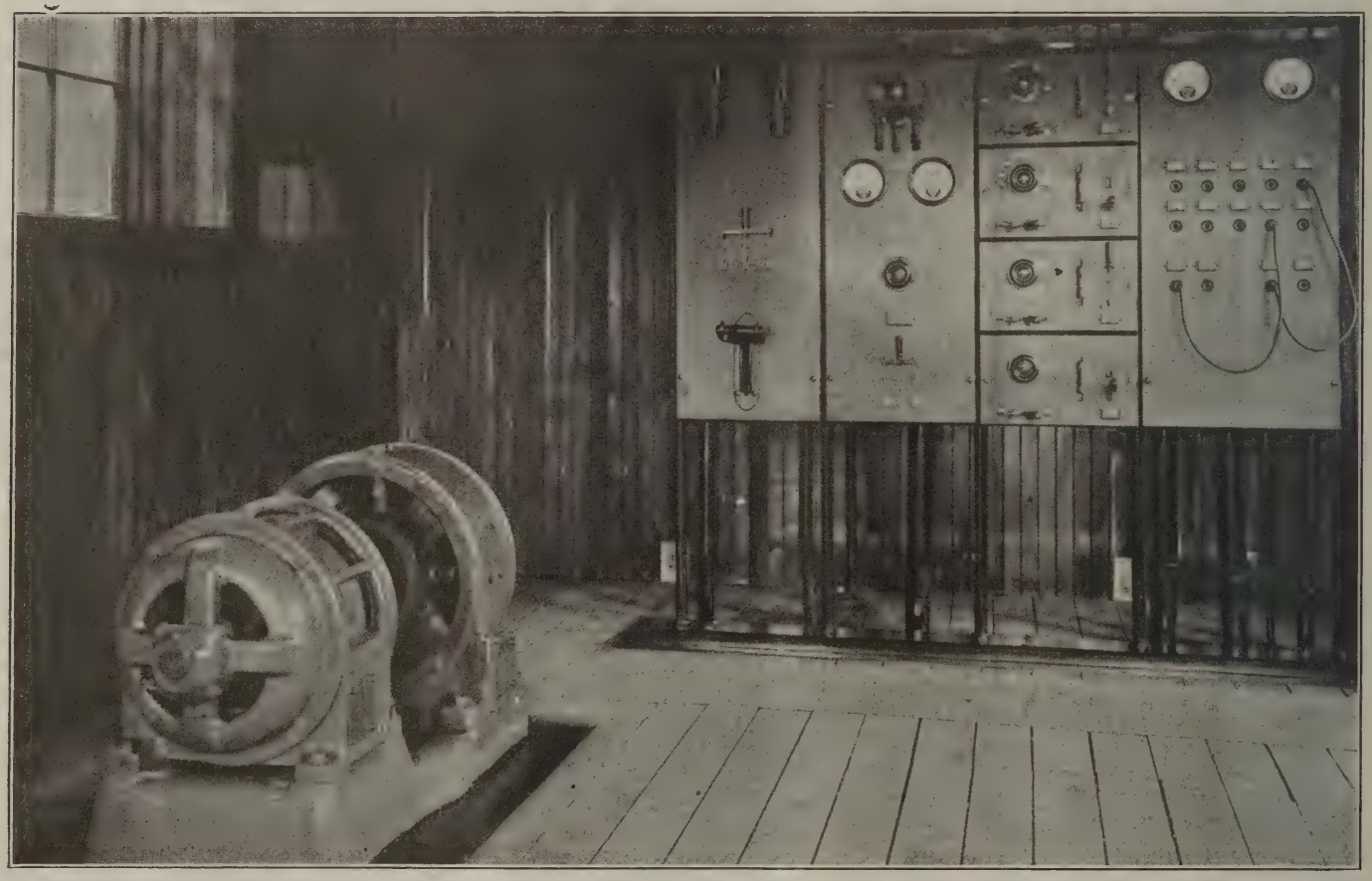
The switchboard consists of a motor panel, generator panel, four section charging panel and a distribution panel. The motor panel contains the line switch, the handle for operating the motor starting compensator mounted on iron framework directly back of it, and the two inverse time limit overload relays. The starting compensator will open the motor circuit on overload or failure of voltage.

The generator panel contains an overload and reverse current circuit breaker, ammeter, voltmeter, double-pole line switch and field rheostat handwheel.

The charging panel is made up of four duplicate sections, each containing a single-pole line switch and protective enclosed fuse, a single-pole double-throw instrument switch for simultaneously reading the charging current and voltage of the battery, a button contact resistance switch and a cardholder. The instrument switch has a spring in the hinge so that it will return to "off" position after taking a reading; this prevents connecting two charging circuits together through the ammeter. The variable resistance is mounted directly on the back of the section and taps from it are connected to the studs of the button contact switch. Each section, therefore, is self-contained and can easily be removed if necessary for repairing.

The distribution panel contains the instruments which are connected to the instrument switches on the charging panel, and 14 single polarity plug switches. Four of these plug switches are connected one to each of the four charging sections, nine to the yard outlets and the remaining one to the outlet at the repair bench. Cardholders are placed over each switch and contain cards, four of which are numbered to correspond with the cards on the charging sections and the others numbered for the battery locations to which the switches are connected. Any car battery location may be connected to any charging section by means of a flexible cable with plug on each end placed in the proper switches.

The ultimate capacity of this station is twice that already installed. With this design it is easy to add switchboard sections to meet increasing demands without disturbing the present switchboard, and there is plenty of room for additional plug switches on the distribution panel.



Power Plant for Charging Train Lighting Storage Batteries at New Haven, Conn.

EMPHASIS IS PLACED on the necessity of prohibiting smoking on railroad property where inflammables are handled. Federal and general managers are asked to issue instructions prohibiting smoking in shops, coaling stations, piers, warehouses, storehouses, freight houses and offices, including record rooms, and around freight platforms and all places where inflammables are handled or stored. Watchmen and other employees in charge of property must see to it that the rule is enforced.

THE RAILWAY APPLIANCE EXHIBIT

Preparations are under way for holding the National Railway Appliances Exhibit in Chicago at the Coliseum next March in connection with the stated meeting of the Railway Signal Association and the annual meeting of the American Railway Engineering Association. In this connection the board of directors of the National Railway Appliances Association held a meeting on November 12 and allotted space to 118 companies. The exhibitors who were awarded space at this meeting are listed below:

Adams & Westlake Company.
Adams Motor Manufacturing Company.
A. G. A. Railway Light & Signal Company.
Air Reduction Sales Company.
Ajax Rail Anchor Company.
Alexander Milburn Company.
American Abrasive Metal Company.
American Hoist & Derrick Company.
American Steel & Wire Company.
The American Valve & Meter Company.
The Anchor Company.
Armco Iron Culvert & Flume Manufacturers' Association.
Associated Manufacturers of Malleable Iron.
The Austin Company.
Balkwill Manganese Crossing Company.
Benjamin Electric Manufacturing Company.
Bethlehem Steel Company.
The Buda Company.
Burden Iron Company.
Bryant Zinc Company.
E. M. Camp.
Carbic Manufacturing Company.
Carnegie Steel Company.
Cast Iron Pipe Association
Chicago Bridge & Iron Works.
Chicago Flag & Decorating Company.
Chicago Malleable Castings Company.
Chicago Railway Signal & Supply Company.
Chipman Chemical Engineering Company.
Cleveland Railway Supply Company.
Crerar, Adams & Co.
Diamond State Fibre Company.
Paul Dickinson, Inc.
The Duff Manufacturing Company.
Edison Storage Battery Company.
Electric Storage Battery Company.
Thos. A. Edison, Inc.
Fairbanks, Morse & Co.
Fairmont Gas Engine & Railway Motor Car Company.
Federal Signal Company.
The Frictionless Rail.
General Electric Company.
General Railway Signal Company.
Wm. Graver Tank Works.
Grip Nut Company.
W. & L. E. Gurley.
Hall Switch & Signal Company.
Hegeman-Castle Corporation.
Hatfield Rail Joint Manufacturing Company.
Hayes Track Appliance Company.
Hubbard & Company.
Hazard Manufacturing Company.
Ingersoll-Rand Company.
H. W. Johns-Manville Company.
O. F. Jordan Company.
Kalamazoo Railway Supply Company.
Kaustine Company.
Kelly-Derby Company.
Kilbourne & Jacobs Manufacturing Company.
Keystone Grinder Manufacturing Company.
Kerite Insulated Wire & Cable Company.
Lackawanna Steel Company.
Layne & Bowler Company.
Lipman Refrigerator Car & Manufacturing Company.
Long, Chas. R., Jr.
M. W. Supply Company.
Macomber & Whyte Rope Company.
MacRae's Blue Book Company.
Madden Company.
Marsh & Truman Lumber Company.
The C. F. Massey Company.
McGraw-Hill Publishing Company.
The Miller Train Control Corporation.
Mercury Manufacturing Company.
Monroe Calculating Machine Company.
Mudge & Co.
National Carbon Company.
National Lead Company.
The National Lock Washer Company.
The National Malleable Castings Company.
Northwestern Motor Company.
Nichols, Geo. P., & Bro.
National Surface Guard Company.
Ogle Construction Company.
Okonite Company.
O'Malley-Beare Valve Company.
Page Steel & Wire Company.
Pittsburgh-Des Moines Steel Company.
Pocket List of Railroad Officials.
Positive Rail Anchor Company.
Protective Signal Manufacturing Company.
Pyrene Mfg. Company.
Q & C Company.
The Rail Joint Company.
The Railroad Supply Company.
Railway Review.
Ramapo Iron Works.
Reading Specialties Company.
Signal Accessories Company.
Simmons-Boardman Publishing Company.
Southern Pine Association.
Squire Cogswell Company.
Snow Construction Company, T. W.
Standard Asphalt & Refining Company.
Standard Underground Cable Company.
Toledo Scale Company.
Track Specialties Company.
Templeton, Kenly & Co.
Underwood Typewriter Company.
Union Switch & Signal Company.
U. S. Wind Engine & Pump Company.
Verona Tool Works.
Volkhardt Company.
Walls Frogless Switch & Manufacturing Company.
Waterbury Battery Company.
Wayne Oil Tank & Pump Company.
Western Electric Company.
Wyoming Shovel Works.

ALLOY STEEL FOR A.C. WELDING

In general, all alloy steels can be successfully welded by the electric arc, the idea in general being to use an electrode which will deposit as near as is practical a welded metal similar to the parent metal. The difficulty is that due to the extremely high temperature of the arc and to the small mass of metal heated at a time a bare wire metallic arc will be so exposed to the atmosphere that the alloys and steel will combine with the oxygen and nitrogen of the air in different amounts according to their separate chemical affinities, thus varying the composition of the weld from that of the electrode or parent metal. One rough way to overcome this is to add the alloyed elements such as manganese in excess so that a part of the original remains in the weld. The amounts which can be deposited thus are small and again referring to manganese are a maximum of .35 of 1 per cent because by thus smothering oxidation by more oxidation,

the weld is porous due to the gases escaping and no welding results say at over .6 manganese in the electrode. This is true of carbon, copper, chrome, nickel, titanium and other steel alloys besides manganese.

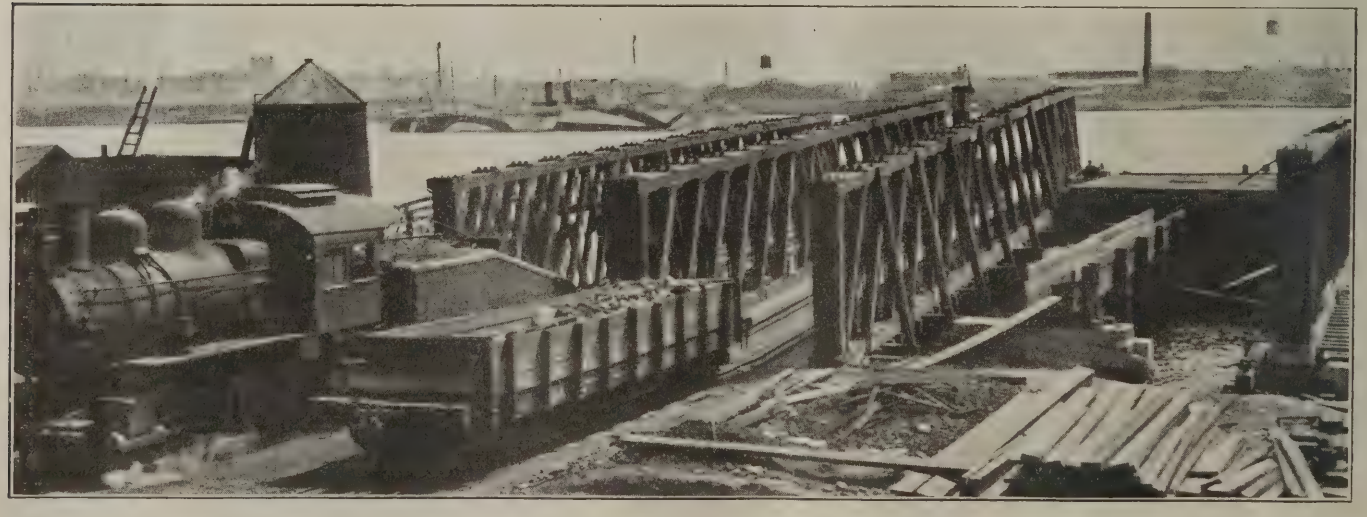
The time for the reaction and bringing the slag to the surface is so short in the process of welding that efforts to hasten this action are in the right direction. Such efforts are the coating of the electrode with various covering which fall into two general classes: slag covered electrodes, and flux coated electrodes, or combinations of the two. The flux coated electrode has chemicals which pass into the arc together with the steel to free the resultant welded metal mainly of oxide and pass off as gas, whereas the slag coated electrode furnishes a covering over the molten metal and in some cases an envelope around it, preventing the air from combining with the molten steel while it is at the point of greatest chemical affinity. The flux covered electrode fails in the case of a long arc in that more impurities are absorbed by the molten metal than the flux can take care of in the short time provided, whereas the envelope covered metal fails in the case that impurities are only present in the electrode or parent metal and shielding from the air will not remove them.

A combination of a covering and a flux is then necessary for a first-class electrode, which, when properly applied will result in a weld free from oxides, nitrides, or cyanides, and as thoroughly ductile as the best annealed steel casting can ever be. Welding is inherently a casting process, but the castings are made in small quantities, each deposition annealing the previous layer, and if the weld is carefully made of successively thin layers or strings ending with a heavy deposition of metal with a high heat, which last deposition is removed in machining, the weld will partake almost of the qualities of rolled plates. In fact, the qualities of ordinary structural steel can be fully equalled with an electrode which has the content given above, and much progress is being made with special steels which deposit welded metal at nearly the content of the parent metal. "Deposited" welding metal is different from the metal in the electrode in that the arc removes some of the impurities in greater proportion than others. The difference has to be made up in the electrode, and so far high carbon, high manganese, chrome, nickel and vanadium steel alloys have been successfully welded. There has been much progress made in the inclusion of the alloy steels in the covering of the electrode and work is progressing along this line also. Chemical analysis of electrode material is necessary, but not all that is essential. The electrode must be of such structure and even density that it will pass smoothly through the arc without sputtering. The only way to tell this is to try it. In the case of applying envelope coated electrodes, there is great danger of slag and in the case of completely covered electrodes, even where the slag is not included in the weld, it remains as a covering on the first layer and must be removed completely before the application of succeeding layer. This covering in some electrodes, can be removed with a heavy wire brush, which brushing is a highly desirable feature with any method of welding in successive layers.

The question of slag inclusion in each layer depends upon the expertness of the operator, but the chances are lessened by an electrode which is covered longitudinally on one side only which with the bare side advancing prevents a much lesser chance of slag inclusion, although allowing for the covering of the molten metal during its period of greatest affinity and the passing successfully of the flux into the metal during its period of reaction.

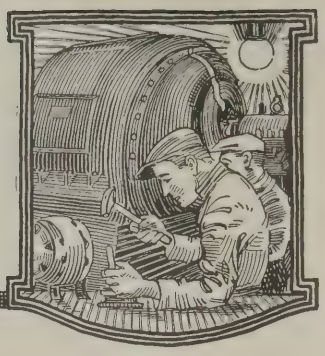
The ingredients used in the most desirable coverings are, first: an inorganic substance, under the action of the arc, which generally is a silicate, a fluxing reagent, popular ones being aluminum, titanion, boron and magnesium —together with an inert substance which will bring the slag to the surface quickly, which is generally a calcium compound, the method of applying these ingredients determining the cost of the electrode and the ease with which the reaction and weld takes place.

In order to cover the added requirements of slag and flux covered electrodes, a high open circuit voltage must be provided, which is always ready to rise to its open circuit or inductive value on a tendency to open circuit or when starting, and alternating current apparatus gives these requirements automatically and inherently.



Before the War Governor's Island In New York Harbor Was Mostly Barracks and Parade Ground. Now It Is Covered with Warehouses and Has a Sizeable Railroad System.

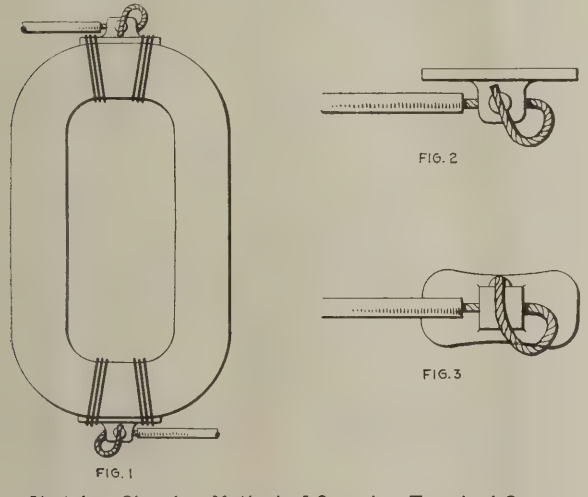
PRACTICAL STUNTS



Overcoming a Loose Contact

By E. C. Meilloret.

On a certain type of axle generator we have brass terminals on all field coils as shown in Fig. 1. This illustration also shows the manner of binding these terminals under the tape covering of the coil. Only the square part of the terminal projects beyond the tape. Fig. 2 shows a top view, and Fig. 3 a side view of the terminal. On one or two occasions we found a machine that would not build up, in fact, gave every evidence of an open field,



Sketches Showing Method of Securing Terminal Screw

and yet on motoring invariably would operate O. K., having no tendency to race.

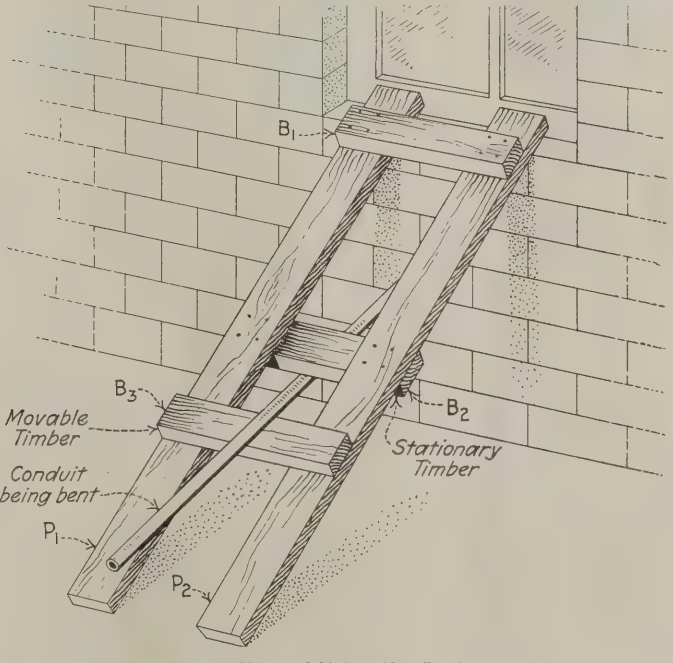
In overhauling the generator I found that a terminal screw had worked loose, causing a poor contact, which kept getting worse as it arced and corroded. The reason the machine worked all right on motoring was evidently, because 32 volts were sufficient to overcome the loose contact, but when it came to building up from its own residual magnetism, which seldom develops over 2 volts, it was quite another matter, as 2 volts could not force current where 32 volts could.

In order to overcome this difficulty I leave about three-quarters of an inch of spare wire project from the terminal and after tightening the screw properly bend back the wire in the slot of the screw and fasten it with solder as shown in Figs. 2 and 3. This serves the double purpose of locking the screw, thus presenting the possibility of its turning loose and also makes a better electrical contact. I have used this stunt for the last two years and have not had a failure of that kind since.

An Improvised Rack for Bending Pipe or Conduit

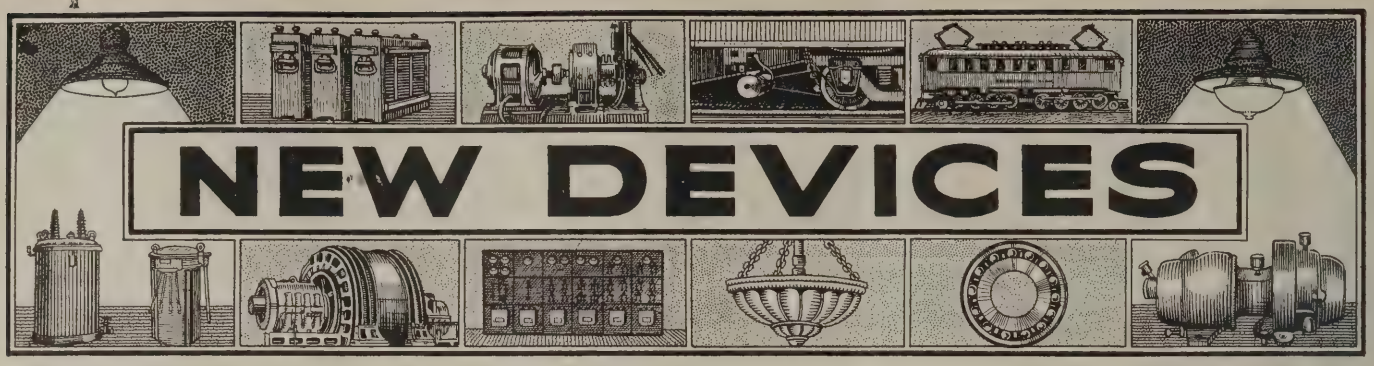
A. J. Cannon

On any job where it is necessary to bend a few medium or large-size tubes, an improvised bending rack like that illustrated can be assembled in a few moments. The raised end may, as suggested, be supported on a window sill or on a pile of brick, rock, or other similar material. This device comprises merely two principal timbers, P_1 and P_2, and a couple of blocks, B_2 and B_3, arranged across them as indicated. It is usually desirable to nail a third piece, B_1, across their upper ends to prevent the timbers from spreading apart. To bend a conduit with this improvised tool, the tube is merely inserted under the piece B_2 and movable timber B_3 is shifted to the de-



One Way of Using the Rack

sired location. The mechanic then throws his weight on the free end, thus forming the bend. A bend cannot ordinarily be made with one setting of B_3. It is, on the contrary, necessary to do the thing by increments. That is, with one setting of B_3 the tube is partially bent; then B_3 is shifted backward or forward as may be required and the tube bent further. This process is continued until the desired number of bends in the tube has been obtained.



Tumbler Switches

The Hart & Hegeman Mfg. Co. are now making Tumbler Switches both in the flush and surface types.

On installations, where handles and covers of surface switches frequently drop off, or are maliciously removed, this Tumbler Switch is especially satisfactory, as it eliminates any trouble of this kind.

The arching shape of the cover in the surface type not only adds to the attractive appearance of the switch, but also helps to ward off blows and to protect the switch from injury, when installed in manufacturing buildings.

Three Types of Tumbler Switches

The switches are furnished in Single Pole or three-way types with ratings of 3 Amperes, 250 Volts, or 5 Amperes, 125 Volts and 5 Amperes, 250 Volts or 10 Amperes, 125 Volts.

The standard finish of covers is polished brass.

Two types of plate are furnished for the flush switches. One type has an embossing around the center, the other type has an insulating ring which furnishes additional insulation for the plate. The standard finish is Brush Brass.

Panel Board Switches

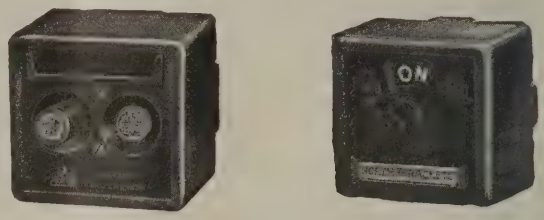
The new panel board push switch recently produced by the Hart & Hegeman Mfg. Co. has a special feature in the unbreakable base. There is no porcelain used in the switch, thus eliminating breakage expense and bother.

The base is of metal and holds the mechanism in exact alignment. Heavy strips of special insulating composition, which is unbreakable and unburnable, insulate the base from the contact plates. The contact plates have forks instead of holes for the screws. This saves considerable time and trouble when inserting the screws for fastening the switches to the bus-bars.

The cover of the switch is of black composition with a holder for a card showing the circuit control.

The spacings of the holding screws on these new switches are 1½-in. on centers each way to meet the standard spacing of the panelboard manufacturers.

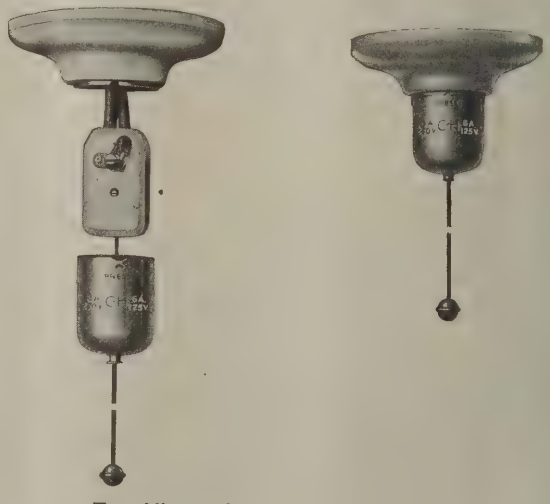
An "H. & H." Panel Board Switch of the rotary type is also now made with these 1½-in. spacings. Spring contact arms allow the bus-bar screws to be fastened down tight without danger of breaking the porcelain base from any unevenness of the bus-bars or base of the switch.



Two Panel Board Switches

New C-H Pull Switch

A new pull switch recently placed on the market by the Cutler-Hammer Manufacturing Company of Milwaukee has a one-piece white glazed porcelain base which fits directly over a standard 3¼-inch outlet box. The two screws which are furnished with the outlet box are used to fasten this switch to it. The shell lock used for attaching the shell to the base is the same as that used on all C-H push sockets as well as on other types of C-H pull switches. The mechanism used, which is the same as that used on all other C-H pull switches, is made



Two Views of the New Pull Switch

of two pieces of porcelain securely fastened together and containing a rotary switch mechanism operating on a steel shaft. There are two holes in the halves of the porcelain so arranged that they permit feeding the supply wires through them, which prevent vibration and operation of the switch from loosening the contact screws. This type, as well as the other types of C-H pull switches, have the high capacity rating of 6 amperes at 125 volts, instead of the usual 3 amperes at 125 volts. Their large capacity makes them of particular value for controlling large groups of lamps, or lamps of high wattage.

Ceiling Snap Switches

To meet the growing demand for a heavy type of Ceiling Snap Switch, The Hart & Hegeman Mfg. Co. is now producing such a device, which is rated at 2 Amperes to 10 Amperes, 250 Volts.

This switch can be furnished to give single pole, double

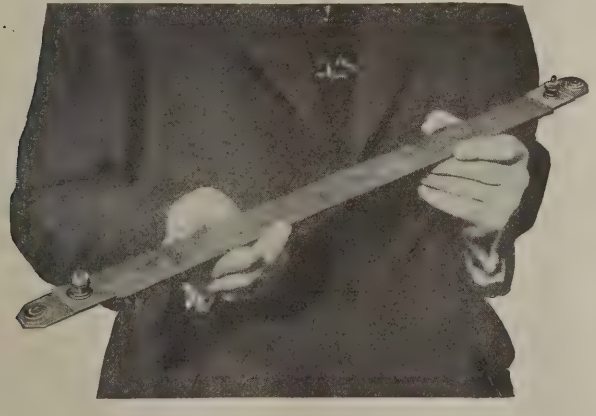
Ceiling Snap Switch

pole, three-way, two-circuit and three-circuit connections.

Covers are in nickel finish, and ten feet of black cord is furnished with each switch.

A New Electric Heating Unit

A new electric heating unit of the steel-jacketed type has recently been placed on the market by the Cutler-Hammer Mfg. Company, Milwaukee, Wis. This unit is



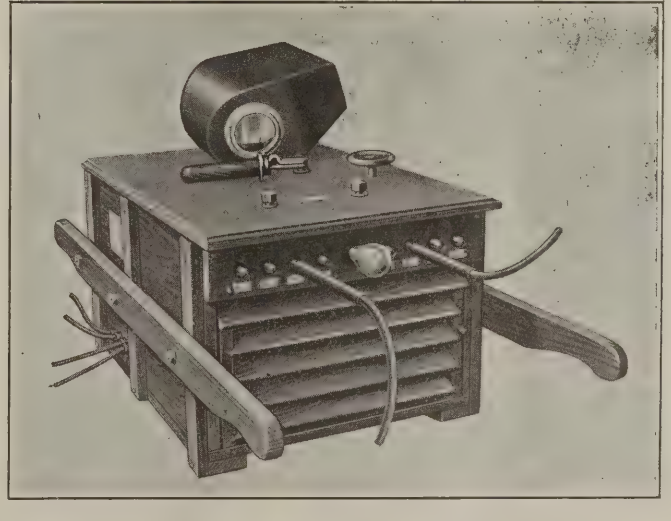
The New Electric Heating Unit

about the size of an ordinary two-foot rule, 1½ in. wide and 3/16 in. thick. It can be used, wherever electric current is available, for heating small rooms, signal and gate towers, instrument houses, flagmen's shanties, etc. The number of units required depends upon the service and other conditions such as temperature, construction and size of room. The units are rated at 500 watts and may be connected to any direct or alternating current lighting or power circuits arranged for 115,230 or 250 volts. Because of their heat capacity and shape they can easily be adapted to meet many heating requirements and space conditions. The insulated eyelet holes permit the use of ordinary screws for mounting. The entire unit is built to withstand hard service and vibration, all parts being enclosed so that they cannot jar loose. No porcelain, cement, asbestos or moulded insulation material is employed. The resistor is encased in sheet mica, which in turn is enclosed in a steel jacket. After sealing, the unit is put in a hydraulic press and 25-tons pressure is applied. When mounting these units in frames, they should be spaced to allow a free circulation of air. A distance of about 1½ in. apart has been found satisfactory. When more than one unit is used, multiple connections are usually employed, but it may be found desirable to arrange the circuit to include a switch so that a series connection can be made when it is desired to obtain a varying degree of heat.

Improved A. C. Welding Machine

In the June, 1918, issue of the *Railway Electrical Engineer,* the alternating current welding machine, manufactured by the Electric Arc Cutting & Welding Company, Newark, N. J., was illustrated and described, but since being placed upon the market a number of important improvements have been made in the design.

In the original design the welding terminals were all located on the top of the machine and in this position it was found that they were frequently subjected to mechanical injury. In the new type the terminals are all



Improved Design of Welding Transformer

located on the side of the frame and are all carefully housed so that it is practically impossible for them to be injured by anything dropping from above. Furthermore, when the welding lead is connected to the terminal the hole in the front board is entirely filled up with the end of the welding lead.

Suitable handles have been attached to the sides of the container so that the transformer may be readily picked up and carried by two men from one place to another as may be required.

General News Section

PENNSYLVANIA RAILROAD, Broad Street Station, has had plans prepared for the erection of a new addition to its power house at Butler street and Glenwood avenue. The structure will be one-story, about 18x40 ft., and is estimated to cost $5,000.

COAL LOADING for the week ending December 7, as reported by the Railroad Administration, amounted to 227,782 cars, as compared with 205,110 during the corresponding week of 1917. The total increase this year up to December 14 is estimated at 546,766 cars.

CASH IN ADVANCE for all freight shipments is to be a rule on the railroads of Canada beginning March 1, next, according to a recent order of the Railway Board; exceptions to be made only in the case of large shippers and receivers of freight. These, by giving bonds, can have three days' credit.

CARRYING LETTERS BY AIRPLANE regularly from New York to Chicago has not yet been accomplished. A start was made by the flyers of the Post Office department on each of four different days, but difficulties with engines, or with the weather, prevented satisfactory work, and the letters which started on wings had to be turned over to ordinary mail cars to complete their journey.

THE INDEPENDENT PNEUMATIC TOOL COMPANY announces the opening of a branch office and service station in Cleveland, Ohio, on December 15. A complete line of Thor pneumatic and electric tools and repair parts will be carried in stock at 1103 Citizens' Building, under the management of Hayden F. White, who has represented the company in Detroit, Chicago and Milwaukee districts for some years past.

LINN BRADLEY, CHIEF ENGINEER of the Research Corporation, 63 Wall street, New York, stated in a recent report concerning potash as a by-product of various industries, that the cement industry can be made to yield approximately 100,000 tons of potash, while the iron industry has an even larger tonnage of the same element, as a by-product. As the substance and its closely allied element, sodium, are used to a considerable extent in the electrical field, it is interesting to note that serious consideration is being given to a suggestion that a special potash commission be appointed to consider the question of recovering this produce from the dust of blast furnaces.

RECLAMATION WORK FOR ENGINEERS.—The attention of engineers and technical men is called to the service that is being rendered by the Division of Engineering, 29 South La Salle street, Chicago, for the purpose of giving free assistance to such men in securing employment. This service is particularly welcome at this time when so many technical men returning from the national service are troubled with reclamation problems. Technical men should pass this word along in order that they may help each other and help the men returning from the front. The division asks employers of technical men to place orders for additional help for engineering work of all kinds.

THE ITALIAN-AMERICAN NEWS BUREAU states that a substitute for gasoline has been discovered by Guglielmo Sesti, who announces that he can produce a product that will serve every practical purpose that is now taken care of by gasoline. Among the claims for the new fluid as compared with gasoline are the following: The cost is appreciably less; raw materials are abundant; it has certain adaptabilities to the motors actually in use without any need to substitute others or modify present designs; it is easy and quickly produced by a method which will furnish an unlimited supply and can be manufactured without the installation of complicated and expensive plants.

AIR SERVICE BETWEEN ENGLAND AND AUSTRALIA.—Australian commercial and financial interests are discussing a proposal to connect Australia with London and other parts of the British Empire by commercial airplanes. A company has been formed to finance the survey of an aerial route to London by way of Sydney and Port Said. The possibilities of flying from the commercial point of view are dealt with in a report issued by the Civil Aerial Transport Committee. It is declared that nearly five hours could be saved between London and Paris, one day between London and Turin, twelve days between London and Calcutta and thirteen days between London and Johannesburg South.

Westinghouse to Build Electric Locomotives at Essington

Discussing the prospects for the year 1919 at the Essington, or South Philadelphia, Works of the Westinghouse Electric & Mfg. Co., Mr. R. B. Mildon, assistant to the vice-president, made the following statement:

"We share the general opinion in the industrial field that business will slow down somewhat owing to the readjustment of the industries from a war to a peace basis, but by Spring this phase should be over and then for the next few years we should have a period of prosperity.

"As far as the Westinghouse Works at Essington is concerned, we have enough orders on hand to keep us busy for the next year without considering new business which is now beginning to develop.

"We are at present making nothing here but ship propulsion machinery, but our plans contemplate bringing here all of our turbine and electric generator construction work that is now being handled at East Pittsburgh. Before we can accommodate this additional business, however, we shall have to build several new buildings, including an office building, a shop for making turbine blades, and an electric generator shop. Unless we are

mistaken in our expectations, however, this new construction work should begin this Spring.

"Looking a little further ahead into the future it is probable that we shall in time erect a building for the construction of electric locomotives. The electric railroad situation is unquestionably very favorable and a large amount of electrification will be undertaken in the next ten years. We co-operate with the Baldwin Locomotive Works in the manufacture of electric locomotives and our location here, so close to the Baldwin plant, makes this the proper place to do our part of the work.

"In other words, we plan to build at Essington all of our large and important apparatus, and as the demand for this class of apparatus is certain to increase rapidly from year to year, we expect to see our plant expand in the near future to many times its present size."

Railway Electrical Engineer Cited for Gallantry

George E. Goldthwait, of the editorial staff of the *Railway Electrical Engineer,* enrolled in the first officers' training camp at Plattsburgh immediately after the outbreak of the war. After completing the three months' course there he was assigned to the aviation section and attended the ground school at the Massachusetts Institute of Technology. He was then sent abroad and after a number of months of further training received his commission as first lieutenant. The following information is taken from the Marion, Ind., *Chronicle* of December 14, 1918:

"Another young man from Marion has added glory to the record of Grant county's fighting men. Lieutenant George E. Goldthwait, son of Mrs. E. L. Goldthwait, Gallatin and Fifth streets, has been recommended for a distinguished service cross in France.

"The word has come first in an indirect way to his relatives. Miss Alice Goldthwait of North Washington street, a cousin of Lieutenant Goldthwait, has received a letter from an old friend, William C. Biddle, adjutant-general of the personnel bureau of the general headquarters of the American Expeditionary Forces. Major Biddle is in the decoration section. It is by his kindly thought and remembrance of the family that he was inspired to tell them this good news even before Lieutenant Goldthwait had forwarded the word. Lieutenant Goldthwait is in the aviation section."

Western Electric Company's Plan for Former Employees in Military Service

Former employees who have been given a leave of absence for Military Service and who have been honorably discharged therefrom, and who desire to again take up work in the company, should make application within thirty days after being mustered out of service.

If possible, they will be promptly assigned to work for which their previous experience qualified them, at the rate of pay which others are then being paid for similar work.

If it is not possible to assign them to work immediately, they will be placed on a preferred list until such time as business conditions enable the company to place them. During their continuance on this preferred list they will enjoy the same rights with respect to the Employees' Benefit plan as they had while in the service of the United States, and they may take other employment.

When they are notified of a vacancy they should present themselves for work at the time stated and failing to present themselves for ten days thereafter their leave of absence shall terminate.

Before assignment to any work, their suitable physical condition for such work must be determined in accordance with the regular routine.

Car Lighting Hand Book

The new Car Lighting Hand Book recently published by the Association of Railway Electrical Engineers for distribution among its members has proved so popular that the demand for it has extended considerably beyond the membership of the association. In order that the valuable material contained in the book may be made available to many railroad electricians who are non-members, the association has ruled that the books shall be offered to those desiring them at $2.00 each.

The Railway of the Forty-fifth Parallel

The railway across Europe following the forty-fifth parallel which for many years has been a favorite subject of discussion by various French interests has again been brought up for consideration. Press despatches from Paris under date of November 24 tell of an interview in L'Information with Jules Cels recently appointed Under Secretary of Public Works and Transport in which in speaking of the work of his department, he says:

"Studies are being made of a plan for a great international railway route from Bordeaux to Odessa. There is also a committee studying the project of constructing a tunnel under the English Channel and another through the Vosges Mountains, west of Alsace."

The general line suggested follows the forty-fifth parallel of latitude and runs from Bordeaux to Lyons, then to Milan, Venice and Triest, thence by way of the Save Valley to Agram, the Jugo-Slav center, and thence to Belgrade, Bucharest and Odessa. Most of the railway links in this chain are already constructed, but they are under various administrations, and there are unfinished links, chiefly across Jugo-Slav districts.

Car Lighting Men Hold Banquet

The regular monthly meeting of the New York Electric Car Lighting Association was held in Room 1030 of the Grand Central Station. Being the first meeting of the new year, the business session was devoted exclusively to the election of new officers. The nominating committee presented the following candidates, who were unanimously elected: President, W. C. Kershaw, Penn. R. R.; 1st vice-president, G. R. Humphrey, Pullman Co.; 2nd vice-president, J. J. Lambert, Pullman Co.; treasurer, T. G. Case, Grand Central Terminal; secretary, J. M. Scudder, Grand Central Terminal. Executive committee, F. A. Hodges, Long Island R. R.; Wm. Seaman, Penn. R. R., and J. Leitner, Erie R. R.

In accordance with previously made arrangements the members adjourned immediately after the election to a banquet hall where an excellent dinner and entertainment had been provided.

The indications are that the coming year will see greatly increased interest in the car lighting association along both educational and social lines.

PERSONAL

J. K. MAHAFFEY, who has been representing the Edison Storage Battery Company in Washington in connection with Government business, has been appointed district sales manager of the Pittsburgh District. Mr. Mahaffey has been in the employ of the Edison Storage Battery Company since 1916. His previous connections include the General Electric Company, the Jandus Electric Company, Adams-Bagnall Company, Union Metal Manufacturing Company and the Electric Products Company of Cleveland.

GEORGE SIMONS has been appointed district sales manager of the Detroit district of the Edison Storage Battery Company, Orange, N. J. Mr. Simons succeeds BERTRAM SMITH, who was recently called to the main office at Orange, N. J., in the capacity of assistant general sales manager. Mr. Simons has been associated with the Edison Storage Battery Company for the past three years. He has had valuable experience in storage battery practice, and was for nine years associated with the National Battery Company, Buffalo, N. Y., and with the United States Light & Heat Corporation.

BERTRAM SMITH, for the past three years district sales manager of the Detroit district of the Edison Storage Battery Company, has been appointed assistant general sales manager, with headquarters at the Main Office, Orange, New Jersey. Mr. Smith is known throughout the trade as one of the "old-timers" of the storage battery business, having been active in the sale of lead batteries for many years before the advent of the Alkaline Storage Batteries. Mr. Smith's earlier connections include such positions as western sales manager, secretary and treasurer of the National Battery Company, manager of the Chicago office of the United States Lighting and Heating Company, and assistant manager of the Edison Storage Battery Supply Company, San Francisco.

GEORGE E. MURRAY, whose appointment as electrical and mechanical engineer of the Grand Trunk Western Lines, with headquarters at Battle Creek, Mich., has been announced in these columns, was born on December 8, 1884, at Decatur, Ill. He began railway work with the Wabash in 1903, and two years later went with the Peoples Gas & Electric Company, of Defiance, Ohio. He returned to the Wabash in 1906 to install the machinery and equipment in the new car shops at Decatur, remaining with that road until 1910. He then became connected with the Chicago & North Western, where he had charge of electrical equipment in shops, and, subsequently, was made chief electrician of that road, which position he held up until his recent appointment with the Grand Trunk Western Lines, as noted above.

OBITUARY

WILLIAM I. THOMSON, electrical superintendent of the Safety Car Heating & Lighting Company, died at his home in Newark, N. J., December 10, of pneumonia. Mr. Thomson was prominent in the field of railway car lighting engineering for many years, and to his efforts are due many important developments in car lighting electrical apparatus. He was born in Newark, N. J., June 26, 1876, graduated from Stevens Institute in class of 1897 and served as chief machinist on U. S. S. "Badger" during the Spanish-American war. He was instructor in Applied Electricity at Stevens Institute from 1897 to 1900, and after working in the electrical construction department of the Manhattan Railway Company, New York, for two years, he went to the Safety Car Heating & Lighting Company in 1902.

TRADE PUBLICATIONS

Trumbull Cheer for December arrived with its usual message of Christmas cheer, together with a number of short but interesting articles, the theme of most of them being anti-Germanism.

The National X-Ray Reflector Company is distributing the December number of Eye-Comfort. The loose leaves of this folder are devoted in general to the X-Ray products, and in particular a number of interesting Christmas specialties, chief among which is the Curtis portable.

Ralco Locomotive Wiring Accessories is the title of a new bulletin, No. 47, recently issued by the Central Electric Company, Chicago. This bulletin consists of 12 pages beside a large insert which shows diagrammatically the applications of Ralco devices for locomotive wiring. The first 9 pages of the bulletin describe and illustrate the various accessories and the last 3 pages are devoted to typical wiring diagrams as applied to different types of locomotives in railway service.

The Esterline Company, Indianapolis, Ind., is distributing a four-page illustrated folder, "The Esterline Graphic," in which is described the new model "MS" graphic power factor meter. The new Esterline type "MS" power factor meter has been designed to meet the demands for a high grade rugged power factor meter for portable use as well as for permanent installation on walls and switchboards. These meters are furnished for use on any standard power system and instruments for use on three-phase systems and combining a number of voltage ranges can be furnished. The pamphlet also describes the Esterline type "W" indicating instrument, which is a combination of voltmeter and ammeter and which embodies a number of new features.

Miscellaneous Applications of Electrical Heat by Means of Standardized Units, is the title of the new 4-page descriptive pamphlet being distributed by The Cutler-Hammer Mfg. Co., of Milwaukee. These standardized heating units are known as C-H Space Heaters. They are about the same size as two feet of lath. The blueprint which accompanies the new pamphlet gives all the dimensions of these standardized units. The pamphlet makes special mention of the great variety of applications of these units, important among which are: Crane and Hoist Cabs, Meter Houses, Watchman Houses, Detached or Exposed Rooms, Storage House Offices, Freight House Offices, Temporary Construction Offices, Valve Houses, Sprinkler Riser Houses, Mines, Where Explosives are Present, etc. These space heaters are so easily installed and lend themselves so readily to heating small enclosures and out-of-the-way places that industrial plants are finding new uses for them every day, reference being made to the fact that one plant put 2000 in use last year.

Railway Electrical Engineer

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THE PRINCIPLES OF ELECTRIC WELDING

The process of joining metals through the medium of heat and fusion has been known to man for centuries. Electric welding which is the most recent of all the known means of joining metals, even though it is still in the course of development, is rapidly becoming an important process. It must not be understood that electric welding is still in an experimental stage, for it is not; it has passed from that phase into one of practical development and is receiving careful attention through investigation and actual application by many industries, shops and railroads.

The action of the electric arc when applied to metal surfaces has been searchingly investigated by engineers and metallurgists. Their investigations have brought out many facts which have made possible the practical application of electric welding, and devices of various types are now on the market for welding metals by that means.

Electric welding is of such a nature, its application is so broad and the desire for exact information on the subject so much sought after that the *Railway Electrical Engineer* has arranged to publish a series of articles covering this important development. The introductory article of this series will appear in the March issue and will be followed from month to month by other articles in order of importance. We recommend that the articles be read carefully and then filed away for safe keeping and future reference. The series will be a valuable source of information, as the articles are written by men who have spent much time and study on the question of electric welding. Their success is due to the overcoming of many failures they have encountered during the course of its development.

THE SERVICE OF THE EXPERT

Railway electrical engineers are confronted today with many intricate problems. Correct shop and office illumination, car lighting, yard lighting, electrification, transmission lines, arc welding, electric headlighting, and on some roads, signaling, telephone and telegraph work,—all put such a heavy demand upon the electrical engineer's time that it is practically impossible for him to cope with all of these subjects and to do justice to each.

Here is where the consulting engineer and the testing laboratory with its staff of trained men can be of service to the railroad. These experts are in a position to help solve the railway electrical engineer's intricate problems and to plan and co-operate with him. In this way the railroads benefit by getting the "outside viewpoint" which in most cases, is an unbiased opinion of the facts as they actually are—something that is often overlooked by the railway electrical engineer because he has been living too close to the proposition to ferret out all of the details.

In some instances the consulting engineer plans proper illumination for shops and offices that results not only in the reduction of the number of lamps and a reduction in the current consumption, but also in increased efficiency and output on the part of the employees—a saving that more than pays for the services of the expert.

Care must be exercised, however, in the selection of a consulting engineer. Often a college professor is called into consultation because his fee is a little lower than that of the practical expert. The professor suggests a plan that looks well and that may work out in theory, but which not infrequently fails in practice, simply because he is not thoroughly familiar with the intricacies of electrical problems encountered in everyday steam railroad operation. This subject must be approached by men who have made a study of steam railroad problems and who have carefully followed them up as their life work.

THE NEW SUBSCRIPTION RATE

In the December issue of the *Railway Electrical Engineer* it was announced that the subscription price would be advanced to two dollars a year. There is nothing in the publishing business that does not cost very much more than it did a year ago. Paper has increased in cost more than two hundred per cent, and it is difficult to get at any price. Printers' wages have been raised in keeping with the upward trend of wages in other industries so that the increase in the cost of printing alone has been no small item. Every technical journal must be generously illustrated if the articles presented are to be clear and intelligible to its readers, and the cost of engraving, which has always been one of the largest cost factors, was practically doubled at the first of the year.

Some of the increases mentioned have been in the nature of a gradual development and we have been able to absorb them in other ways, but the more recent advances, particularly that of engraving, have been so sudden that it has been impossible for us to continue the publication of the *Railway Electrical Engineer* at the old rates, however much we should like to do so. Even at the present two dollar rate, the subscriber pays less than one-half of the actual cost of the publication.

It would be decidedly wrong for us to give the impression that we expect to double the size of the *Railway Electrical Engineer;* to do that would be to place ourselves back in our former position, or worse, as regards cost, and it is very doubtful if such an increase would be

of material benefit to our subscribers. Our policy in the future will be the same as it has been in the past,—to give to our readers the best obtainable, up-to-the-minute information on the subjects in which they are vitally interested.

THE LABOR PROBLEM

Reports coming from many cities throughout the country show clearly that the labor situation has greatly changed since the signing of the armistice. In practically all of the larger towns where such statistics are recorded there appears to be a decided surplus of unemployed labor. Without doubt the cessation of hostilities together with the stoppage of many of the war-time industries are the primary causes for this surplus. Men are being discharged from the training camps in great numbers and while many of these are inclined to take a holiday before entering the pursuits of civil life, there is unquestionably a certain percentage of them who lack the ambition or desire to take up work of any kind; they belong to the class which work but intermittingly. There is no doubt also but that the extensive employment of women during the war is a large contributing factor to the existing labor condition.

There can be no question but that the recently discharged troops are largely responsible for the surplus and when we consider that only a very small portion of our army has been discharged the problem begins to assume a more serious aspect. It is very true that many of the men now under arms have positions awaiting them upon their return to civil life. A very notable instance of this kind is illustrated in the Seventy-seventh division, which consists of men from in and around New York City. A recent canvass of this division developed the remarkable fact that nearly every man in it had a position waiting for him. It is too much to expect, however, that all of the men will be as fortunate as the Seventy-seventh division, and unless the various industries throughout the country begin to extensively manufacture peace-time products, the indications are that within a short time the unemployed labor of the nation will present a very critical problem.

High prices are still prevalent and to all appearances they will continue to be for sometime to come. Occasionally the price of some commodity may drop for a short time, but for some unexplained reason it soars again to its former value and in some cases a little higher. Under these conditions it is easy to understand the attitude of labor, for it is perfectly plain that the labor organizations having once secured the whip hand will not tamely submit to a general reduction of wages. On the other hand, as long as the manufacturer is obliged to pay high wages his natural tendency will be to employ as few men as he possibly can to successfully run his business. This means that the army of unemployed may grow larger and it is not unlikely that serious difficulties may arise in many localities before the last of our disbanded army is finally absorbed in the industrial world.

There is one method, however, whereby the situation can be materially improved, and that is by discharging the men from the service at the point of their enlistment. It is to be hoped that the government will put this plan into operation, thereby distributing the men in the territory from which they originally came. This will relieve the congestion in any particular part or parts of the country and should be a factor of great assistance in restoring the men to civil pursuits.

On the railroads the problem of returning soldiers does not present many difficulties for the reason that in the majority of cases railroad employees who entered the government service have retained their seniority rating with their respective companies. This means that the soldier or sailor employee will fit naturally into practically the same position he would have filled had he remained in continuous service. This, of course, applies only to such railroad men as are affected by seniority regulation, but as the majority will undoubtedly come within this classification, the problem of taking care of the few who do not will be one of comparative simplicity. Regarding soldiers and sailors who have not heretofore been railroad employees, it would seem that the least possible consideration that could be shown them when they seek work would be to rank them as preferred applicants.

In general, throughout all of the large industries where the labor turn-over is great in normal times, returning soldiers and sailors should be given preference. In consideration of their sacrifices, both financial and physical, it is comparatively a small matter to insist that these men be given the best possible opportunity to install themselves once more in the peaceful pursuits of industrial life.

WHERE DO YOU STAND?

Industry must be stimulated to make jobs for the returning soldiers and great numbers of them may be used to good advantage by the railroads. Probably never before have the railroads been more in need of maintenance and reconstruction work.

Times are ripe in our country for starting a wave of unparalleled prosperity and now at this critical time many are suggesting that the wheels of industry be stopped while a fight is waged over who shall get the lion's share, labor or capital. When two dogs get to fighting over a bone they have found, the proper moment has arrived for a third to make off with the coveted treasure.

Owing to labor conditions in England, Yarrow & Company, well known shipbuilders and engineers, have announced that they intend gradually to diminish their output on the Clyde and to develop their work on the Pacific coast of North America. One of the directors of the company when interviewed, spoke as follows: "It is because the industrial prospects are better in America than they are here, not on the Clyde alone, but all over the country. We believe that better economic results can be obtained in America. American workmen in any given time handle twice as much material as a corresponding number of men on this side." This is a fine reputation which should be maintained and it is this fact which makes it possible for workers in the United States to get twice the pay given to workmen of corresponding trades in England.

Can business be stimulated by adopting the policy of many workers, namely, to do as little as possible? Is it not now the time to let the other fellows do the quarreling?

The Internal Transportation Problem Solved

Some Interesting Facts and Figures Showing Why Modern Industrial Trucks Have Become Popular

By H. C. Yost

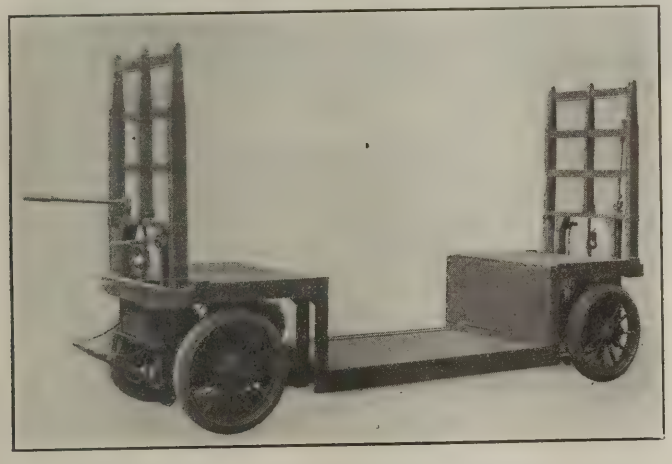
SUPPOSE, Mr. Reader, you saw the following advertisement in various newspapers and other publications, would you write for further particulars, or arrange for an interview?

SITUATION WANTED.

"A thorough, willing and experienced worker desires a permanent position with your company. Can furnish A-1 references. Honest, sober, capable, efficient, reliable and steady. Can accomplish the work of from 6 to 12 men in about one-sixth of the time. Not affected by climatic conditions, and not a member of any union. Will accept any position, anywhere, for service day or night, rain or shine, Saturdays, Sundays and Holidays at from 10 to 20 cents an hour. S. B. I. Truck or Tractor.
"Care Industrial Truck Manufacturers."

There are about twenty different types of strong willing workers on the market, one or more of which has been especially designed and built for your particular class of service, if you will only take the time to investigate.

These sturdy little labor aiding machines are better known as storage battery industrial trucks, tractors and



One of the Most Familiar Types—the Baggage Truck

trailers, and they are maintaining their reputation of being able to fulfill your requirements in a manner which will not alone save time, labor and money, but will cost nothing to install, except for a suitable charging apparatus. They will operate practically every place where you have been employing men with hand trucks. They will even run over paths and roadways which are not fit for a hand truck or trailer, although the efficient superintendent is seeking methods to improve his conditions, and provides either a concrete or a smooth roadway, which not alone increases the speed and capacity of his equipment, but greatly reduces the operating and maintenance expenses.

The industrial truck or tractor will negotiate fairly steep grades, run inside of box cars, up and down on elevators having sufficient size and capacity to support such loads, run through narrow aisles and doorways, and operate out of doors during rainy and snowy weather. Unskilled laborers can be taught to handle these machines within a short time and soon become proficient operators.

Referring to the "ad," what is meant by stating: "He can accomplish the work of from 6 to 12 men in about one-sixth of the time?" The maximum capacity of one man with a hand truck is 400 lb. and with such a load he does not average over one mile an hour, throughout the day. The wages paid for this class of work vary from 40 to 80 cents an hour. Let us consider an average of 60 cents an hour, or $4.80 for an eight-hour day. The maximum capacity of an industrial truck is 4,000 lbs., or the equivalent load of 10 men with hand trucks. This means that an operator at $4.80 a day, plus the running and maintenance expense of the truck at 20 cents an hour, or $1.60 a day, equals $6.40 as the total expense. A computation will show that the saving on the capacity of the industrial truck alone, amounts to $41.60.

Electric truck, equal to 10 men, at $4.80, or	$48.00
Expense of truck and operator	6.40
	$41.60

The speed of the electric truck with maximum load is from 5 to 6 miles an hour, which is 5 to 6 times faster than a man with a hand truck. Figuring an average of 5 miles an hour, this would equal the services of five men, or a total saving of $208 a day for each electric truck. The electric load carrying truck occupies only a little more area than one man with a hand truck, so that the saving in space and congestion is another important item to be considered.

To many readers, the above figures may appear absurd and somewhat imaginary. Perhaps they are in some instances, but have you ever kept an actual record of the amount of work accomplished by one or more men with hand trucks? Some will say, "The industrial is never loaded to capacity; it has to remain idle while it is being loaded and unloaded; the wear and tear, depreciation and other items have been figured too low, and so on."

But let us ask the same questions of the man with the hand truck. Does he always carry 400 lb. on his truck? Does he exceed the speed limit of one mile an hour? Does he ever stop for a drink (I mean water), a smoke, a chat with his fellow worker? Is he always on the job?

Have you ever had the pleasure of watching a gang of men trying to move a large and heavy piece of machinery, or a crated automobile? As many as twenty men are sometimes employed on a job of this kind. Do they all push or pull? Not on your life: but the old saying, "Many hands make light work" is very appropriate in this particular case. The greater portion are lending a helping hand, but not pushing very hard. Some, and there seems to be quite a few, are the bosses, who know how the material should be handled, but as no two agree, the result is, the crate is moved in any old fashion, until it reaches its destination.

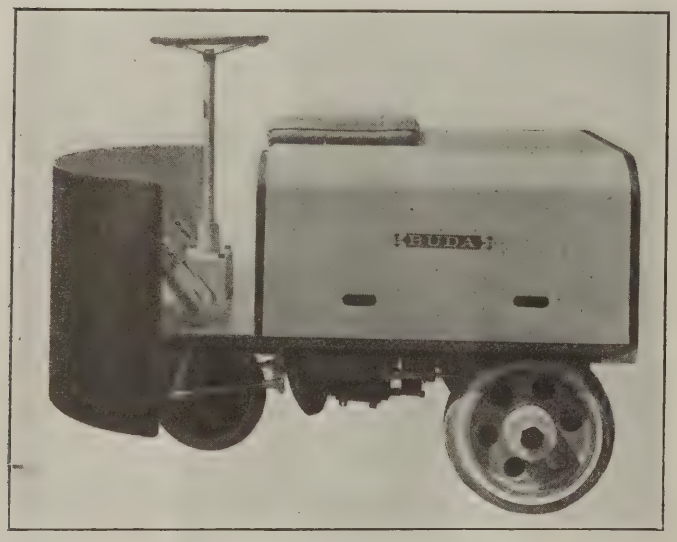
The installation of one or more electric trucks has

been the means of carrying from 25 to 1,500 tons of material over and above the old hand truck methods. The actual increased capacity for any particular installation depends on many conditions, such as, paving, grades, length of hauls, class of material to be moved, aisles and doorway spaces, headroom, size and capacity of elevators and floors, and layout of buildings.

If superintendents and engineers would make an accurate study and report, covering the time and expense for hand trucking, there would be less mystery about the savings derived from the installation of storage battery industrial trucks and tractors.

Many people, interested in these machines, have only a faint idea of the value of an electric truck or tractor, and when told that they vary in price from $1,200 to $3,000, depending on the size, capacity and battery equipment, they invariably reply, "Why, I can buy half a dozen 'flivvers' for that." There is no doubt about that, but of what use would they be for the particular work for which the industrial was designed? It must be understood that although the initial cost of the electric truck is much higher than certain types of gasoline vehicles, the low maintenance and operating expense, comparative freedom from adjustments and repairs, its many safety features, simplicity of operation, and the increased amount of work which it can accomplish, more than offset the first cost. There are actual records of installations where the initial expenses were charged off the books in from three to six months after the machines were placed in operation.

The actual expense of operating a load carrying truck varies from 50 cents to $3 per eight-hour day, depending on the cost of electricity, and the conditions under which the machine is operated. One large railroad and



The Buda Three Wheel Tractor

steamship company, which has more than 25 industrials in service, charges 65 cents a day against each machine; this includes every expense outside of the operator's wages. These trucks have been in almost continuous operation, practically every day and night, for over four years and are still working efficiently.

The average cost of operating and maintaining one of these storage battery industrial trucks is figured as follows:

Assume that the initial cost of the machine is $1,600 complete.

Fixed charges, including insurance, interest on investment, taxes, etc., at 6 per cent	$96.00
Depreciation on machine, $1,000, at 10 per cent	100.00
Depreciation on battery, $450, at 20 per cent	90.00
Depreciation on tires, $120, at 25 per cent	30.00
Repairs, electrolyte, etc.	25.00
	$341.00

Electric Power to Charge the Storage Battery

Direct current at 110 volts with an average of 22 amperes equals 2.4 kw., which for a period of 5 hours a day amounts to 12 kw. hrs. Electricity at 2 cents per kw. hr. equals 24 cents and for an average of 300 days a year equals $72.

A Three Wheel Tractor Pulling a Loaded Lumber Dolly

Fixed charges, depreciation, repairs, etc.	$341.00
Cost of electricity	72.00
Total	$413.00

Figuring 300 working days a year, this amounts to $1.38 per 10 hour day or less than 14 cents an hour. Even allowing twice the amount for the cost of electricity, and $100 for renewals, would make a total of $560 a year, or 19 cents an hour.

The charges for a tractor are somewhat higher. Assuming the cost of such a machine is $2,500, the following estimates are obtained:

Fixed charges, insurance, interest, taxes, etc., at 6 per cent	$150.00
Depreciation on machine, $1,400, at 10 per cent	140.00
Depreciation on battery, $900, at 20 per cent	180.00
Depreciation on tires, $200, at 25 per cent	50.00
Repairs, etc.	25.00
	$545.00

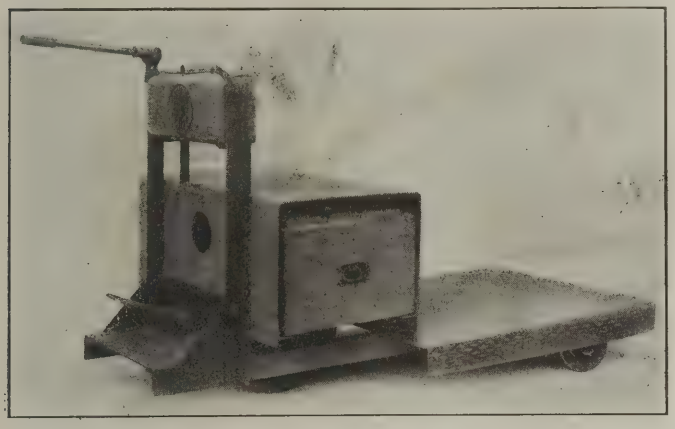
Electricity at 110 volts supplying a direct current of 30 amperes equals 3.3 kw. and for a five-hour period, 16.5 kw. hrs., which at 2 cents a kw. hr. equals 33 cents and for a period of 300 days a year amounts to $99 or a total cost of $644, making a cost per hour of less than 21 cents. Even figuring twice the amount for electricity and allow $100 for repairs, etc., will give less than 27 cents per hour.

The Electric Baggage Truck

No doubt everyone is familiar with the electric baggage truck in service at almost every railroad station of any size and importance. Comparatively a few years ago

all the trunks, bags, luggage, boxes and express packages were placed on hand trucks or wagons and moved by the slow man-power method, much to the discomfort and annoyance of the traveling public and particularly to those who only allowed themselves a few minutes to catch a train.

What do we see today at these terminals? Practically the elimination of all hand propelled vehicles and the substitution of modern electric machines, which carry much larger and heavier loads, more rapidly and in a manner which does not interfere or inconvenience the passengers. In many railway stations, the companies have provided



A Three Wheel 3,000 lb. Load Carrying Truck. The Motor Is Located in the Front Wheel and the Truck Steers on the Two Rear Wheels.

separate levels for the movement of these machines, thus increasing their speed and capacity.

What has become of the hand truckers? They have either become drivers of these electric vehicles, or advanced to other positions requiring the better application of their abilities.

Was there any serious objection on the part of these hand truckers to their advancement in position, increase in salary, elimination of 10 hours of hard manual labor, and better working conditions? We have never read or heard of any. Then why should men in similar lines of work, fight against the installation of the electric truck in factories, warehouses, piers, shops and industrial plants, which will offer them the same inducements as those at our railway stations?

What has resulted from this great labor saving invention? The demands for other types of electric machines which could be used in various classes of service. To-day we have about twenty different models to select from, each designed for a specific duty. A brief description of these different types may be of assistance to the readers.

The Storage Battery Load Carrying Truck

The electric industrial truck is a small three or four wheel vehicle propelled by an electric motor, which receives its supply of electricity from a suitable storage battery located either on top or under the platform of the truck. The chief features of the machine are, its ability to carry maximum loads of 4000 lb.; to operate in crowded and congested areas; to turn in a very short radius; quick and economical replenishment of power; simplicity of operation; interchangeability of parts; adaptability to widely varying uses and conditions; ability to be "always on the job"; fireproof construction; thorough reliability; and extremely low operating cost.

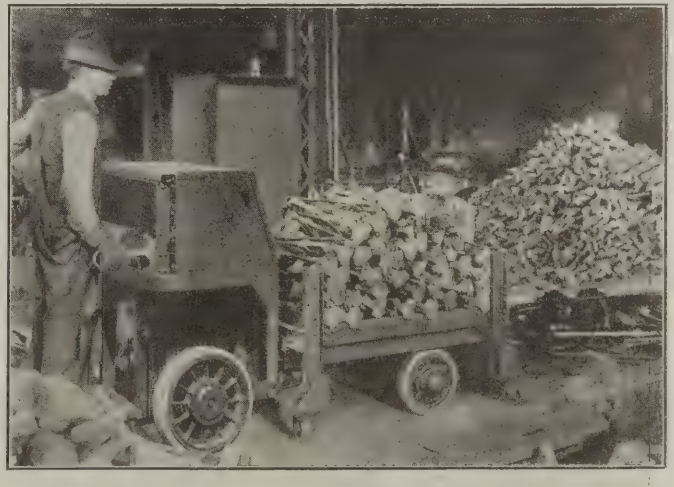
Types of Industrial Trucks and Their Uses

There are three principal types of industrial trucks, namely; the load carrying machine; the elevating platform or lift truck, and the tractor. Variations of these main types, include the crane truck, those equipped with side or end dump bodies, the baggage truck, specials, and the combination truck and tractor.

The load carrying platform truck.—This type of machine, as the name implies, is designed to carry material on its platform, and has a maximum capacity of 4000 lb. It is equipped with a storage battery either of the lead or Edison type of ample watt-hour capacity to carry maximum loads for a period of ten hours, or to cover a distance of from 15 to 30 miles a day, without recharging. These cells are either carried in a separate compartment on top, or suitably supported under, the loading platform. They are so arranged in trays, that they can be removed when discharged and freshly charged cells substituted, thus providing practically continuous service.

The industrial truck operates at a speed of from 6 to 8 miles per hour when empty and from 4 to 6 miles per hour when loaded to maximum capacity. Some are equipped with special gear ratios for a higher rate of speed, while others have greater gear reductions for climbing grades.

The machine is mounted on either three or four wheels, equipped with solid rubber tires of the pressed-on or quick demountable type. All trucks are propelled by heavy duty series wound electric motors, which drive one, two or four wheels. The controllers are constructed



An Elevating Platform Truck. The Structural Iron Platform Mounted on Casters Is Raised from the Floor, When Loaded, and Carried to Its Destination.

for industrial truck service, and provide two, three or four speeds forward and reverse. The types of drive include the chain, worm, spur and the motor in wheel. Trucks are of the two or four wheel steer, the latter being generally used where a very short turning radius is required. Brakes are of the internal expansion or external contracting type, and are applied either by depressing or releasing a suitable pedal operated by the foot.

The industrials vary from 6 to 12 feet over all, and

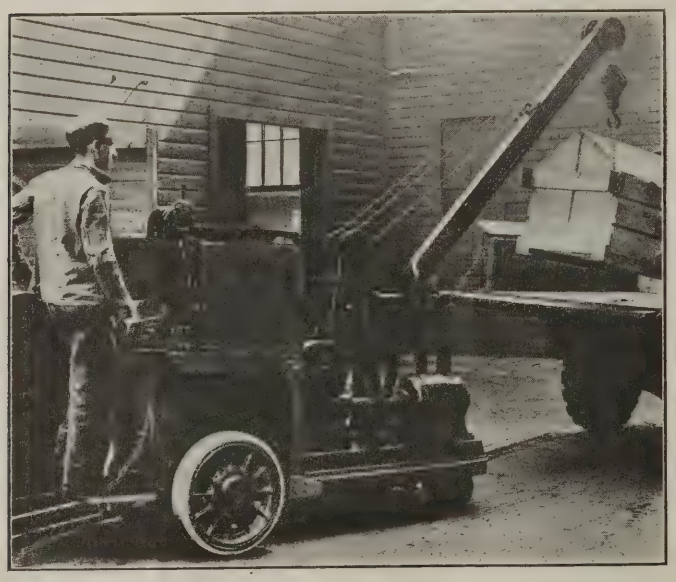
weigh complete with battery from 1600 lb. to 3000 lb.

Simplicity of operation is one of the chief features of all machines. They are provided with the latest safety devices, are fire-proof and as near fool-proof as possible.

The load carrying platforms are made in various widths, lengths and heights, so they will meet conditions. Practically all platforms are made in sections and hinged so as to give access to all mechanical and electrical parts. The truck which has a platform about 24 inches above the ground has been found best adapted for general all around service, while the low platform, about 11 inches above the floor, is suitable where heavy material has to be transferred from place to place and where it is not economical to employ extra labor to lift or tier the goods above a certain height.

The elevating platform truck.—The details of construction of this machine are to a certain extent similar to the load carrying trucks except that the platform is as near to the ground as practicable usually about 11 inches above the floor, and this platform can be raised or lowered by hand or by a suitable electric motor. The truck is designed to run under wood skids, platforms or low trailers, on which material has been placed, to lift these platforms, carry them to the desired location, deposit them and return either with empty or loaded platforms. This feature permits the machine to be continuously engaged, for while the truck is in service, the skids or platforms are either being loaded or unloaded.

This type of truck can accomplish practically the same service as the tractor, except that the latter does not carry any load but is dependent entirely on trailers,



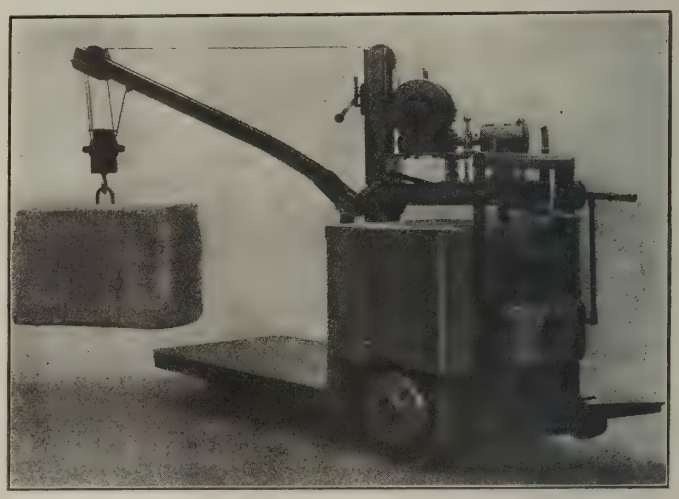
The Elwell Parker Crane Truck

which it pulls. Their field of operation is practically unlimited, as they can be used as load carrying machines without the use of skids, or they can travel into spaces where only load carrying trucks can go, and they can carry their material to various floors by means of an elevator.

The electric tractor.—The design and construction of the tractor is quite different from those described above. It is used exclusively as a power unit to pull material loaded on trailers.

These machines are equipped with three or four wheels, two or four wheel drive, and one, two or four wheel steer. The capacities vary from two to ten tons. The storage battery, of approximately twice the number of cells and watt-hour capacity, as supplied in the industrial types, is located above the wheels and so arranged that the weight is about equally distributed to give added traction and to prevent bucking, when starting with heavy loads.

For extremely narrow aisles, runways and where a



Crane Truck With Compensating Boom Lifting 1,800 lb.

very short turning radius is essential, the three wheel machine, using the single front wheel to steer, has proved very desirable. For general service where heavy loads are to be drawn and for outside as well as inside work, the four wheel tractor of either the two or four wheel drive is preferable. The motor is of the heavy duty series wound type, having about twice the horse-power of those supplied in the industrial trucks.

Most of the tractors have a driver's seat located over the storage battery compartment, which prevents the machine from being operated until the seat is depressed, thus completing the electrical circuit. Others have a foot pedal which has to be released or depressed before the machine can be operated.

The controller is of the same general type as supplied in the load carrying machines, and has three or four speeds forward and reverse. The usual safety features are included in all models.

Practically all tractors have larger wheels and tires of a wider tread than those supplied on industrial trucks.

The types of drive include the worm, chain, spur and motor in wheel.

Steering is accomplished by means of a lever or a wheel operating a worm which turns one, two or four wheels.

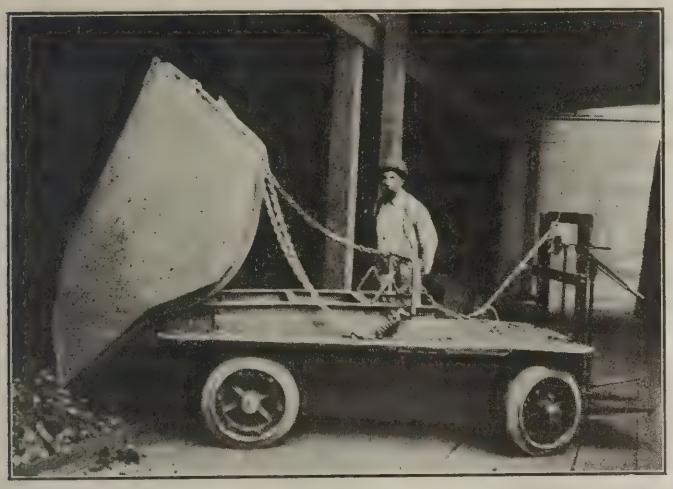
In the majority of installations, the service which the tractor is called upon to perform, demands pushing as well as pulling trailers, so they are equipped with suitable bumper plates and coupling connections at both front and rear.

Other Models

The crane type machines are similar to the two general types of load carrying trucks, except that on this particular model there has been mounted a hand or electri-

cally operated crane. These trucks vary in size and capacity and are being employed in foundries, machine shops, automobile factories and in various other plants where heavy material has to be lifted, transported to some other part of the plant and placed in position in storage, or in a box car for shipment.

The use of side or end dump bodies which are rigidly fastened to the chassis or those temporarily mounted on the platform of the truck are also extensively employed where coal, sand, gravel, fertilizer and other loose material has to be transported. The particular advantage of the quick detachable body is that when it is not



A Quick Detachable End Dump Body on a C. W. Hunt Load Carrying Truck. Note Extreme Dumping Angle

used for carrying loose material, it can be removed and the truck used for carrying miscellaneous goods.

Recently there has been a large demand for a small light machine which could be used for general service in warehouse, factories and buildings, where the floors and elevators are of insufficient capacity and size to support or accommodate a larger standard type of machine. Several models have been produced within the last two years which have found a ready market.

Probably one of the most recent developments, is a small three wheel machine having a capacity of 3000 lb., which has a driving motor located in the front wheel, and steers by turning the two small rear wheels. The truck which is 82 in. over all, has a platform 48 in. long by 37 in. wide and is slightly less than 9 in. above the ground. It turns in less than seven feet to the extreme outside edge of the platform. The battery is divided into two parts and supported on either side of the driving wheel. The top of the battery compartment is only 28 in. above the floor, thus giving an extremely low center of gravity. Heavy sheet steel is used throughout, affording ample protection to all mechanical and electrical parts. A heavy duty controller provides two speeds, forward and reverse. The weight of this machine complete with lead cells is 1675 lb.

Probably no other subject in connection with interior transportation is receiving more consideration and investigation at the present time, than the economical handling of all classes of material. The present scarcity of labor and its increased value, the need of greater production, the betterment of shop, factory, industrial plant and warehouse conditions, demand for more efficient conduct of industrial pursuits, and economic reasons, have one and all combined to bring about a change in the expensive methods of manufacturing and conveying materials.

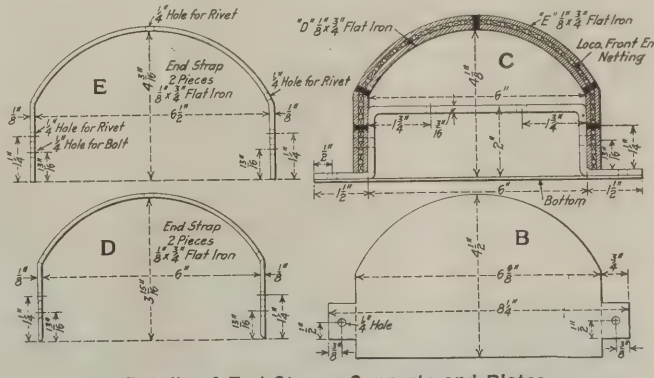
The application of labor aiding machinery has not alone been confined to cranes, hoists, winches and conveyors for lifting and carrying miscellaneous goods, nor to elevators and other machinery confined to fixed paths of travel, but is even more marked in the larger employment of storage battery industrial trucks, tractors and trailers, which have been installed to replace the old fashioned and expensive hand propelled equipment, and to eliminate the greater portion of the manual work considered essential a few years ago.

The old question of the advantage of replacing hand trucks by electrically propelled vehicles is still current although not so prominent as in the past. For the few skeptical persons, we have only to refer to concerns in similar lines of business who have purchased one or more of these machines and have found that such installations have resulted in remarkable reductions in handling costs and saving in both time and labor.

If the present scale of wages is to be maintained and foreign competition met, the present cost of man-handling material must be reduced by substituting efficient, economical, electrical or mechanical machinery. The storage battery industrial truck or tractor offers its services as a means of assisting you in the solution of your internal transportation problems. Will you avail yourself of this opportunity?

A METAL HOUSING FOR ELECTRIC HEATING UNITS

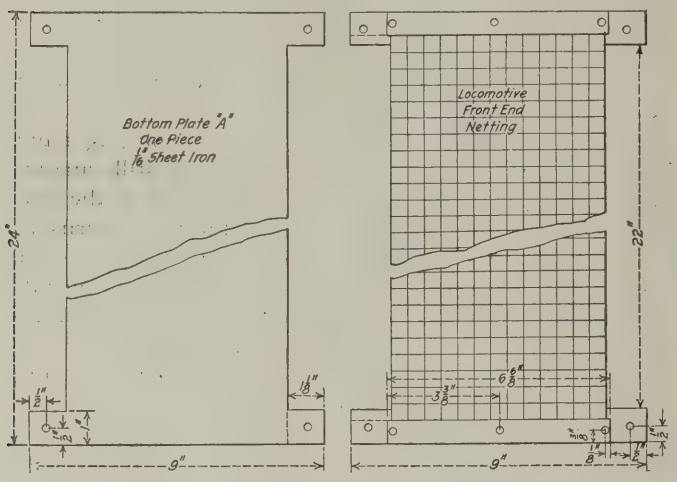
The heating of turntable cabs, crane cabs, pump houses, freight checker stalls and other small buildings by means of stoves, hot water or steam heaters is sometimes objectionable because of the small space available for the installation of such heating apparatus in buildings of that character, and also because the method of regulating the amount of heat is usually such that it is hard



Details of End Straps, Supports and Plates

to maintain an even temperature. Electric devices are aiding in overcoming these objections. Units of various capacities have been installed on different roads to meet special requirements and in general the service has proved to be of considerable advantage over other methods of heating even though the cost of current is large compared to that of coal. One road that is using

electric heating to some extent has designed a substantial metal housing for the heating unit which it uses. These units are steel jacketed about the size of an ordinary two foot rule, 1½ in. wide and 3/16 in. thick. The housing which is shown in the illustration has been designed to accommodate from one to four of these units. When more than two are required it is necessary to mount the third and fourth on the under side of the supporting frame. The electrical connections can be arranged in such a way as to permit one, two or more of them being turned on at one time, either in series, multiple or series-multiple. As a result of the different combinations of connections it is possible to get varying degrees of heat.



The Housing Assembled Showing Details of Bottom Plate

The housing for these heating units consists of a number of metal parts which, when assembled, make a strong and durable covering. This covering serves to protect the units from being damaged and prevents anyone not concerned with its maintenance from getting at the units or changing the connections. It consists of a piece of locomotive front end netting 12 in. by 23 in. which is bent into the proper shape and fastened at its ends between two pieces of ⅛ in. by ¾ in. strap iron which are cut to the size and bent into the form shown in *D* and *E*. These pieces are riveted together at the points indicated. This much of the assembly is then mounted on two supports made of 3/16 in. by 1 in. strap iron as shown in *C*. Stove bolts fasten the parts together through holes drilled 13/16 in. from the bottom edges of the outer covering as indicated. The end covers which are shown at *B* are made from 1/16 in. sheet iron. These are also held in place by the same stove bolts previously mentioned. It is necessary, however, to bend the two projecting portions of the plates so that they fit around the end of the housing with the ¼ in. holes in position for inserting the stove bolts in the holes of the end supports *C*, and the end straps *D* and *E*. The bottom plate shown at *A*, is made from a 24 in. by 9 in. piece of 1/16 in. sheet iron cut to the size and shape shown. There is no means provided for fastening the bottom plate to the rest of the housing except through the holes provided for fastening it to the floor, wall or other support. In case it is desired to install this electric heater so that it can be moved from one part of a room to another stove bolts can be used to hold the bottom plate to the remaining portion of the housing.

The question of wire entrance depends on the method of installation. If conduit is to be used, which is usually the case, a hole of the proper size is cut into one of the end plates and the conduit is fastened in by means of a bushing and lock nut. Sometimes it is desirable to fasten a snap switch onto the same end plate for controlling the heating units.

Inspecting One of the New Railroad Guns

Railroad Electrification Facts and Factors

An Interesting Comparison of the Operating Characteristics of Steam and Electric Locomotives

By A. J. Manson*

WE have learned from the previous article of the many advantages gained by electric operation. Electric operation has brought about a different viewpoint. To apply electric locomotives correctly, electrical engineers have analyzed service conditions to an extent never considered before by the steam man. In this comparison we are therefore considering the general characteristics and limitations of the steam locomotive as viewed from the standpoint of the electrical engineer. When the characteristics of the two types of machines are compared, namely, the electric and the steam locomotive, we find the electric locomotive far superior for railway work. These benefits do not apply alone to passenger trains, but to freight trains of the heaviest haulage.

The steam locomotive consists of two distinct parts—the boiler and the engine, each of which is designed for the service in which the locomotive is to be used. The boiler is limited in size, owing to the space available, and therefore must be worked to its limit so as to deliver the greatest possible amount of steam. The engine is distinct from the boiler and its mechanical dimensions, as well as the boiler pressure determine the tractive effort available at the drivers. The tractive effort of the simple engine can be easily calculated from the following formula, since all factors are concrete and mechanical, and are known.

$$TE = \frac{0.85\ P \times C^2 \times S}{D}$$

where TE = rated tractive effort at rim of driving wheels in pounds
P = boiler pressure in pounds per sq. inch
C = diameter of cylinder in inches
S = stroke in inches
D = driving wheel diameter in inches

From this formula it will be noted that the only variable part is the boiler pressure, so that with full boiler pressure in the cylinders, the maximum tractive effort is obtained. A steam locomotive cannot work steam to its full stroke so that it will deliver, at starting, the rated tractive effort as obtained from the above formula. This maximum tractive effort in general corresponds to about 22 per cent adhesion between the drivers and the rail. That is, with this coefficient of adhesion which represents good rail conditions, the locomotive as generally designed has just enough power to slip the wheels. Loads on the locomotive must therefore be of such a maximum value that there is a small percentage of tractive effort available for possible starting under maximum grade and load conditions. The locomotive must be rated in terms of maximum load in tons for the division over which it operates, and this maximum tonnage must be corrected for temperature during the winter months. This rating is called the "equated" tonnage rating, and is mentioned because it corresponds somewhat to the continuous rating of the electric locomotive, which we will take up and discuss further on in this article. In case the load was of a greater weight, requiring greater tractive effort, it would not be possible with the steam locomotive to start this load, even if the coefficient of adhesion was raised by means of sand blown under the drivers.

As the wheels turn and the speed increases, the available tractive effort falls off slowly, until a point is reached at which the boiler can no longer supply the steam required by the cylinders at full stroke. To attain higher speeds the cut-off must be shortened, and this results in reduced tractive effort. It is evident, then, that the cylinder and driving wheel dimensions do not alone determine the available tractive effort, but that the steaming capacity of the boiler enters into it. For practical purposes, heating capacity can be taken as directly proportional to the total heating surface. The available tractive effort at any speed will therefore depend on the relation between the rated tractive effort and the total heating surface.

The electric locomotive does not have two distinct parts. The boiler is at the power house, which may be several miles away. The electric power is transmitted to it over wires or some other form of conductor, and by means of control apparatus, it is "fed" to the motors. The motors are mechanically connected to the drivers, and the electric locomotive delivers power in the form of tractive effort, just as the steam locomotive does.

The tractive effort in this case, depends on the number of motors that are mounted in the locomotive and connected to the drivers. As these motors are usually all of the same size and design, the total power of the locomotive is a multiple of the power which one motor can exert. Knowing the electrical characteristics of each motor, we can determine the total power of the locomotive. The only fixed concrete part which enters into the calculation of the tractive effort is the wheel diameter. The force from the motors, i. e., the turning moment or torque, is not dependent upon fixed quantities, such as diameter of cylinders, length of stroke and boiler pressure, but upon the electrical characteristics which vary with the amount of electric current taken by the motor.

The torque of the motor is the pull which it can exert at one foot radius from the center of the armature shaft, i. e., at any point in a circumference of a circle 24 in. in diameter. The formula then becomes:

$$TE = \frac{T \times 24 \times G \times \text{gear efficiency} \times N}{D \times g}$$

Where TE = tractive effort
T = torque of motor
G = number of teeth in gear
g = number of teeth in pinion
D = diameter of driver in inches
N = number of motors.

The above formula is a general one and considers gearing as the mechanical connection between the motors and the drivers. With gearing, the speed of the driving axle is changed from that of the motor shaft by the ratio $\frac{g}{G}$. As the power at the motor shaft and driving axle

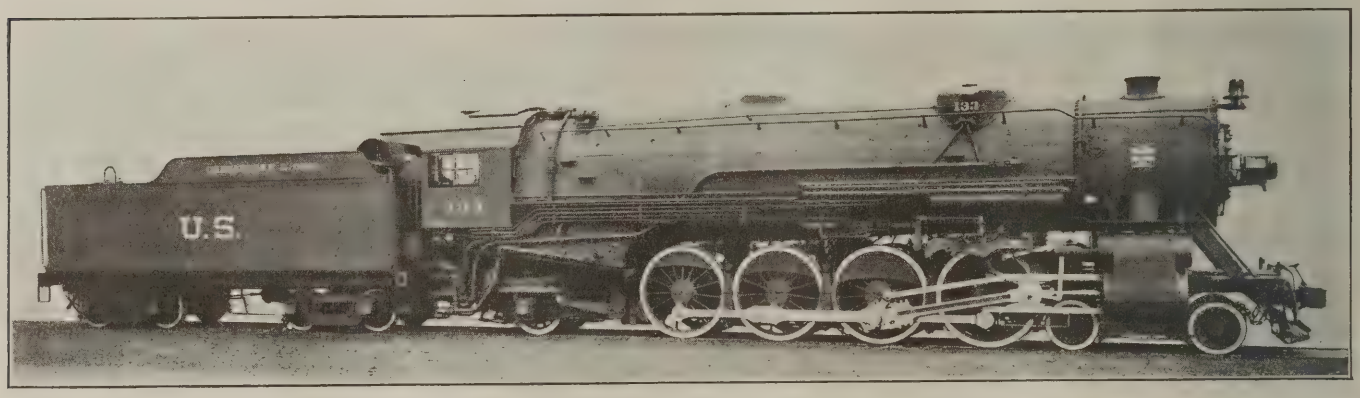
*Westinghouse Electric & Mfg. Co., New York.

are the same, less the gear loss (expressed in the formula as "gear efficiency"), the torque at the axle must increase by the ratio $\frac{G}{g}$. The torque being measured at one foot radius, and the tractive effort at the wheel treads, the tractive effort will be to the torque as $\frac{24}{D}$. When side rods are used with no intermediate gearing, g and G are eliminated, as is also the gear efficiency.

The torque of the motor can not be compared with the steam in the cylinder. The value of the torque and hence the tractive effort depends on the amount of current passing through the motor, while the resulting tractive effort due to steam in the cylinder depends on pressure. The engineer controls the amount of current to the motor so that, within limits, as large a torque as desired can be obtained from the motors. The maximum tractive effort is not fixed; it is not dependent on a maximum constant pressure, as is the case with the steam locomotive. There is, however, a relation between the torque delivered by the motor and the current used. The design of the motor determines what this relation is and it can be calculated from the number of turns in the field, armature, etc., but for all practical purposes there is no formula. So that to provide a ready means of enabling the railroad man to calculate the tractive effort and to know the performance of the electric locomotive under consideration, a set of curves are drawn, known as the characteristic curves. These characteristic curves show the relation between the current taken by the motor, the torque developed and the revolutions. This data is then used to make up a set of curves for the complete locomotive, so that it is possible to read off the total current taken by the locomotive, the pounds tractive effort and the corresponding speed in miles per hour. The tractive effort is obtained by the formula given, and the miles per hour by multiplying the r. p. m. $\times$ D $\times$ $\frac{g}{G}$ $\div$ 336.

We have seen that the tractive effort depends on the amount of current which passes through the motors, this current value being at the control of the engineer. There is an unlimited supply of power available at the power house compared to that developed by one steam locomotive, and the maximum power the electric locomotive is capable of developing does not depend on a fixed condition as in the case of the boiler of the steam locomotive. It is possible, therefore, to take advantage of extra adhesion with the electric locomotive. This extra adhesion may be natural or caused by the application of sand, and a value as high as 35 per cent has been obtained. It is then a question of sufficient load on the drivers to obtain the maximum drawbar-pull required.

It is not possible to maintain this high maximum tractive effort continuously, which the steam locomotive is capable of exerting, on account of resultant damage to the motors, but there is a tractive effort which can be maintained continuously by the locomotive. This leads up to what is meant by the continuous and hourly rating of an electric locomotive. We have the "equated" tonnage rating of the steam locomotive, which is the tonnage the locomotive can normally handle. It is determined by the load handled, the profile of the road and last, but far from the least, the temperature—low temperatures greatly affecting the rating. This rating corresponds, as nearly as the two entirely different machines can be compared, to the continuous rating of the electric



GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam	Stroke		Inside Diameter	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	28″	30″	69″	84½″	200 lbs.	114⅛″	96¼″	247 45	2¼″ 5½″	20′-6″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
18′-3″	40′-0″	75′-8½″	51500	243000	57500	352000	193700

FUEL	HEATING SURFACES, SQUARE FT						GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER	FACTOR OF ADHESION
Kind	Tubes	Flues	Fire Box	Arch Tubes	Total	Superheater			
Soft Coal	2970	1323	335	34	4662	1085	76.3	58200 lbs.	4.18

Fig. 1—A Modern Steam Locomotive of the Latest Design in Which Are Included Such Features as Will Make Possible the Most Efficient Operation. Below the Illustration Are Given Dimensions, Loads, Tractive Power, etc., Which Apply Specifically to the Locomotive Shown.

locomotive. The continuous rating is fixed, but in a different way than the "equated" tonnage rating. The "equated" tonnage rating means that this is the maximum load it is safe to haul if the train is to be gotten over the road—allowance being made for a reduction in tractive effort due to poor coal and other factors.

With the electric locomotive, it does not mean that if the continuous rating is exceeded the locomotive will not be able to take the train over the road. It will pull the train and do it on schedule, but it may be at the expense of overheating the motors, and the question of whether damage will result depends on the time the overload is maintained. In addition to the continuous rating, there is the hourly rating which is higher than the continuous rating. Starting with the engine cold, the hourly rating is now clear why it is possible to get a large tractive effort for starting or emergency conditions, and why this same tractive effort cannot be used continuously. The loads must be adjusted and regulated, and if the locomotive is worked above its continuous rating for short periods at much higher currents, it will be necessary to have coasts, stops, layovers, or sections where the current is below the continuous rating, so that the average heating effect will not exceed the safe temperature rise. This is of vital importance in the operation of the electric locomotive, but does not apply to the steam locomotive, for as long as the boiler has plenty of water, no harm can be done by operating it continuously at very high percentages of its maximum drawbar-pull.

It was mentioned that the "equated" tonnage rating of

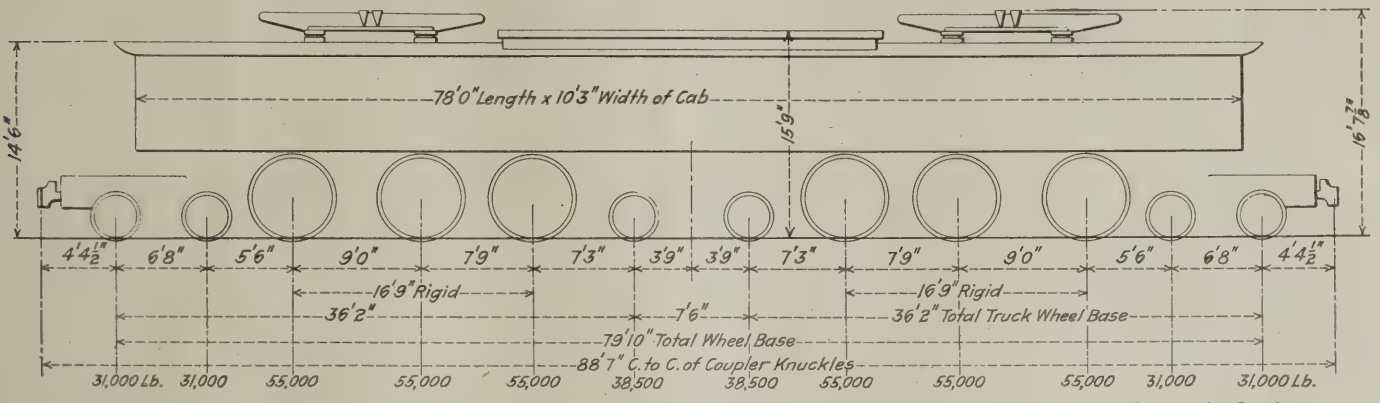


Fig. 2—Outline of Electric Locomotive of the Latest Type, Designed for Passenger Service Over Heavy Mountain Grades.

represents the tractive effort which the locomotive could exert for one hour without overheating the motors. The hourly rating is a rating which does not exist in the steam locomotive. In the latter, the tractive effort depends entirely on the mean effective pressure in the cylinders, while in the former it depends on the amount of current passing through the motors. The current flowing through the motors causes the fields and armatures to heat, on account of the resistance of the conductors. This heat is conducted away by the iron and by radiation, and the whole motor becomes heated. A certain constant current flowing through the motor continuously, will result in a certain temperature rise above the surrounding air, and the extent of this temperature rise will depend on the value of the current. While the electric insulation used in the motor will not be injured if an occasional temperature of 100 degrees C. is reached in service, the ratings of the motors are for a much lower temperature rise—namely, from 60 to 70 degrees C. by thermometer. A continuous current which will give 60 degrees C. rise in temperature is the continuous current rating, and the tractive effort corresponding to this continuous current rating is the continuous tractive effort rating of the locomotive. The hourly rating would be the higher current (and the tractive effort corresponding), which in one hour would give the 60 degrees C. rise. Likewise there can be an indefinite number of ratings for any particular time from say 5 to 10 minutes up to the continuous time. It is the practice, however, to give only the continuous and hourly rating. A very much larger current can be taken for a shorter time without exceeding the allowable temperature rise, and so it is possible to rate the locomotive at a much larger tractive effort for a short time performance. It

the steam locomotive could be likened to the continuous rating of the electric locomotive, but there is one important point which makes the two comparisons unrelated. The equated tonnage rating of the steam locomotive is the rating for a particular division (varying with different service conditions) and is governed by the maximum grade, or by the pull which will be required of the locomotive. The load will be governed by this maximum condition. In the case of the electric locomotive, high tractive efforts can be exerted for short periods of time so that the loading does not depend upon the maximum grade encountered, but upon the whole profile. The load will be governed by what the temperature of the motors will be at the end of the run—not by what the maximum pull may be for 5 or 10 minutes. Therefore, it becomes possible to give the electric locomotive a higher tonnage rating for the same weight upon the drivers than would be possible with the steam locomotive operating over the same profile.

There is one more very important point which should be thoroughly understood and appreciated, when considering the electric locomotive, and that is the "horsepower" rating. Horsepower, as we know, is the product of the tractive effort and the speed. It is a direct measure of the locomotive's capacity to do work. Tractive effort tells how much trailing load can be handled, but it is the horsepower that measures the hourly ton miles. The railroad man is not so much interested in the maximum tractive effort or drawbar-pull which a locomotive can give, as he is in the *speed* at which a certain drawbar-pull can be developed. Electric locomotives far excel steam locomotives in this regard, and the reason that they have made good and that they have come to stay

and will increase in numbers, is that the electric locomotive has a great horsepower output. It has the ability to carry the maximum tractive effort (to speeds two or more times that of the steam locomotive). The steam locomotive is a constant power machine, while the electric machine is only limited by the power lost in the motors resulting in heat.

To better understand what has been covered in the foregoing discussion, an actual comparison has been made of the tractive effort and the horsepower of a steam and an electric locomotive of equal weights, both designed for heavy passenger service over mountain grades. The data of weights, etc., is given by Table I. The steam locomotive is of the very latest design, embodying arch tubes and superheater, with arrangement of driving wheels, etc., as shown by Fig. 1. The locomotive is designed to carry a boiler pressure of 200 lb., which together with cylinders of 28 in. diameter and 30 in. stroke, result in the very large rated tractive effort of 58,000 lb. The electric locomotive is one of the latest, being built for heavy passenger duty in mountain service.

The first comparison made is that of tractive effort. Curves showing the relation between speed and tractive effort for the two types are shown in Fig. 3. The maximum tractive effort of the steam locomotive is 58,000 lb., while that of the electric is 110,000 lb. Reference to the data Table I shows that the weight on the drivers is 330,000 lb., so that the 110,000 lb. tractive effort for starting is based on 30 per

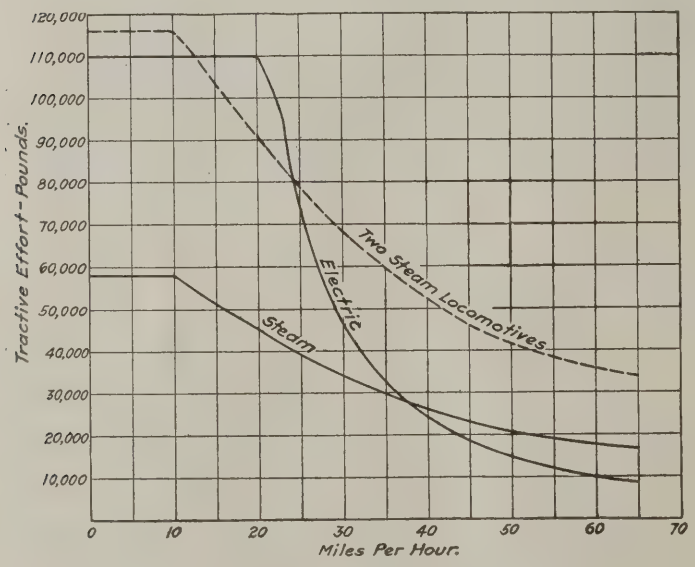


Fig. 3—Speed and Tractive Effort of Steam and Electric Locomotives Compared.

cent adhesion, a very conservative value for the electric locomotive. This maximum tractive effort in the case of the electric locomotive is carried out to a speed of 20 miles per hour, while the steam locomotive cannot maintain its maximum beyond 10 miles per hour. The electric locomotive curve drops rapidly, and at 38 miles an hour both types are the same. To better appreciate what this large tractive effort of the electric locomotive means, a curve has been drawn in, showing what the tractive effort would be for two steam locomotives operating as a double-header. The dotted curve is slightly higher for the maximum tractive effort, but in practical work the one electric could start the same train as the two steam locomotives, and would have an advantage over them up to a speed of 24 miles an hour. When it is considered that on heavy passenger mountain service, speeds do not greatly exceed this figure, it becomes clear that the one electric locomotive is nearly

TABLE I

Characteristics	Steam	Electric
	4-8-2	4-6-2—2-6-4
Weight—engine and 14-ton tender	268.5 tons	266 tons
Weight—engine only	352,000 lb.	532,000 lb.
Weight—engine on drivers	243,000 lb.	330,000 lb.
Number of pairs of drivers	4	6
Weight per pair	60,500 lb.	55,000 lb.
Wheel diameter, inches	69	68
Total wheel base engine and tender	75 ft. 8.5 in.	79 ft. 10 in.
Maximum tractive effort	58,000	110,000
Maximum horse power	2,825	5,860
Continuous horse power	2,825	3,200

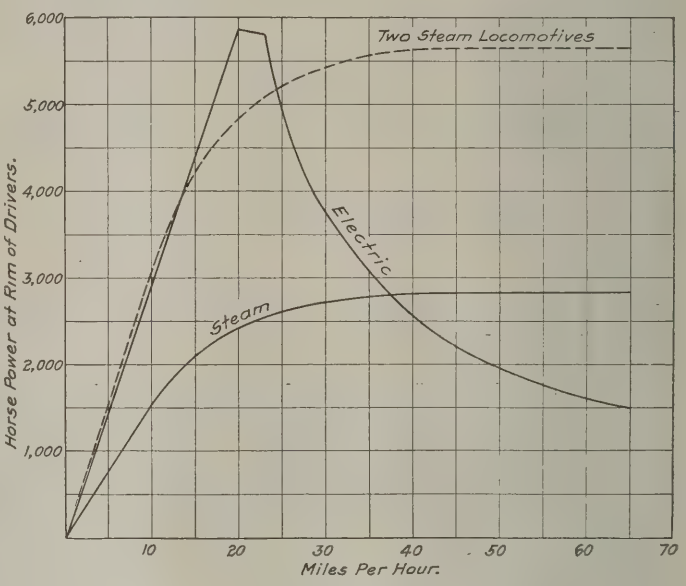


Fig. 4—Curves Showing the Relative Horsepower Developed by Steam and Electric Locomotives.

equivalent to the two steam locomotives. It must be remembered that the two steam locomotives could maintain this speed continuously with a tractive effort of 80,000 lb., while the electric locomotive could not on account of the electric motors requiring a current much above the continuous rating.

Since horsepower is such an important factor, Fig. 4 has been drawn, showing the relative horsepower for the two engines chosen. Here the comparison is even more striking, and the great advantage of the electric locomotive is easily recognized. This electric locomotive of the same weight as the steam, has a maximum developed hp. rating at the rims of the drivers of 5,860 hp. compared to 2,825 hp. for the steam locomotive. And when compared with two steam locomotives it shows, for the working range, the ability to deliver the equivalent in hp. Of course, the continuous rating must not be lost sight of, and for the electric locomotive this is 3,200 hp. The increase in horsepower is due to the increased speed for the same tractive effort. Referring to Fig 3, assume there is a passenger train requiring at certain sections or grades, a tractive effort varying from 50,000 lb. to 30,000 lb. At 50,000 lb., the speed of the steam locomotive would be 16½ miles per hour—the electric, 29 miles per hour—nearly double. At 40,000 lb., the steam locomotive would be 24.5 miles per hour—the electric, 32.

Characteristic curves showing the relation between

speed, tractive effort and the current taken by the locomotive, are supplied by the electrical manufacturers. The set of curves for the electric locomotive under consideration are shown by Fig. 5. From these curves the tractive effort at any speed can be read off directly. Table II was tabulated from these curves, and this data was used to plot the tractive effort curves in Fig. 3.

Horsepower is the product of tractive effort and speed, divided by 375. Applying this formula to the first two columns of Table II, the third column of hp. rating was obtained. This last data was used to plot the hp. curve in Fig. 4.

The tractive effort and horsepower data for plotting

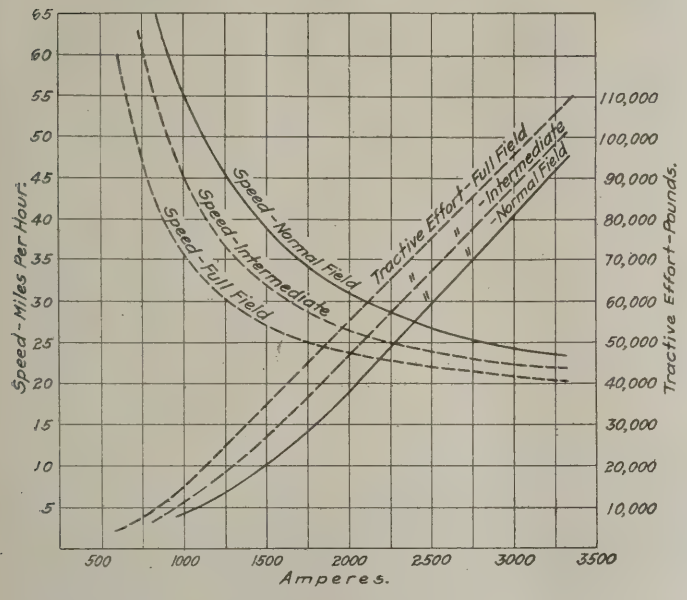


Fig. 5—Characteristic Curves for an Electric Locomotive Using Field Control, Thus Eliminating Resistance Losses.

the steam curves was obtained by calculating the piston speed in feet per minute, and applying percentages of speed factor and maximum hp. corresponding to piston speed. This data is shown by Table III.

Referring to Fig. 5, the set of characteristic curves for the electric locomotive, it is noted there are three

TABLE II

Speed	Tractive effort	Horse power
0-20	110,000	5,860
23	95,000	5,800
25	75,000	5,000
27	60,000	4,320
29	50,000	3,870
32	40,000	3,420
40	24,000	2,560
50	14,500	1,960
60	10,000	1,600

TABLE III

Speed m. p. h.	Piston speed ft. per min.	Speed factor	Tractive effort	Per cent of max hp.	Horse power
0	...	....	58,000	....	0
10.3	250	1.	58,000	55.6	1,570
12	292	.954	55,300	64.3	1,820
15	365	.897	52,000	73.1	2,070
20	487	.784	45,500	85.6	2,420
25	610	.675	39,100	92.3	2,610
35	852	.515	29,900	98.3	2,780
41	1,000	.445	2,700	100	2,825
45	1,095	.405	23,500	100	2,825
55	1,340	.332	19,250	100	2,825
65	1,580	.281	16,300	100	2,825

speed curves and three tractive effort curves corresponding. This locomotive uses "field control," thus eliminating resistance losses. The tractive effort and horsepower curves covered the "normal field condition." To show, briefly, what is gained with this field control, consider the continuous horsepower rating of 3,200 hp. With normal field this corresponds to a speed of 34 miles an hour and a tractive effort of 35,000 lb. If a greater tractive effort is necessary continuously the speed can be reduced by operating on full field when a speed of 24.5 miles per hour is obtained at a tractive effort of 49,000 lb.

The reading of the characteristic curves is easy after once explained. To avoid complication of three sets another set of curves has been included which has only one field position, Fig. 6, but all points apply to Fig. 5, having in mind that the "full field" speed curve goes with the "full field" tractive effort curve, etc.

It is to be noted that all of the curves, namely efficiency, tractive effort, miles per hour and horsepower, are plotted as ordinates with amperes as a base. To show the use of these curves, several assumptions are made. First assume the locomotive is hauling freight up a grade at 11.5 miles an hour. We want to know: (1) How many amperes are collected from the conductor? (2) What tractive effort is the locomotive exerting? (3) At what efficiency is it operating? (4) What is the brake horsepower? (5) How many minutes could the locomotive perform this service without exceeding a rise, in the motor, of 60 degrees C. above the surrounding aid, if locomotive was cold at starting? (6) If locomotive was hot, how long could load be handled before an additional 20 degree C. rise would be obtained?

1. Start at point *A*, 11½ miles, project horizontally

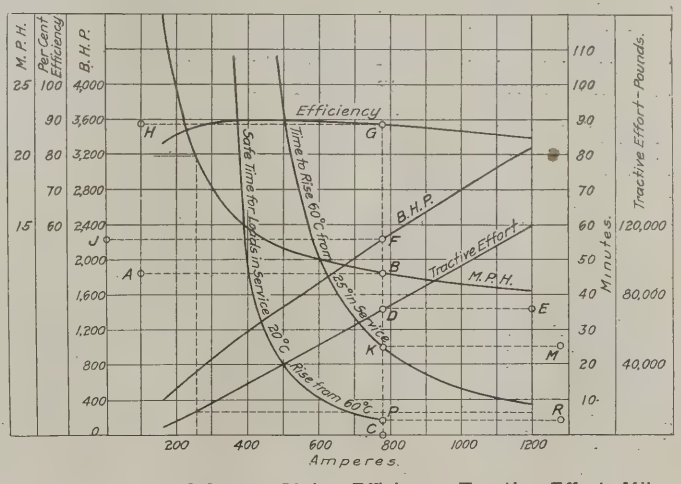


Fig. 6—A Group of Curves Giving Efficiency, Tractive Effort, Miles Per Hour and Horsepower of an Electric Lomotive Under Different Conditions.

to speed curve at point *B*, drop vertically to amperes at point *C*. Ans.: 780 amperes.

2. Line *BC* cuts the tractive effort curve at point *D*, project horizontally to tractive effort scale at right to point *E*. Ans.: 72,000 lb.

3. Project line *BC* up until it cuts efficiency curve at point *G*, project horizontally to left to efficiency scale point *H*. Ans.: 88.8 per cent.

4. Line *BC* cuts the brake horsepower curve at point *F*, project to left to brake horsepower scale point *J*. Ans.: 2,240 horsepower.

5. Line *BC* cuts temperature curve at point *K*, project horizontally to right to time scale point *M*. Ans.: 25 minutes.

6. Line *BC* cuts second temperature curve at point *P*, project to time scale point *R*. Ans.: 4 minutes.

Take another example: How much tractive effort will the locomotive exert when running at 20 m. p. h.? Find 20 m. p. h. on the scale, project to speed curve, then to current scale and current corresponding is 255 amperes, and projecting point where the vertical line cuts the tractive effort curve we get 14,000 lb. tractive effort.

Many other conditions may be assumed, and numerous examples worked out which will help materially to fix in mind the relationship existing between the various factors involved in electric locomotive operation.

RAILROAD ELECTRICAL ORGANIZATION

The result of a recent investigation undertaken for the purpose of determining certain facts regarding the electrical organization on the several railroads, is shown in tabulated form below. Forty roads were requested for this information and 24 replies were received, from which the table was compiled. Although it is quite possible that some minor inaccuracies may be included owing to the fact that all of the replies received were not entirely clear, the statement as a whole may be regarded as a correct summary of the information furnished.

Road	Electrical Head	Department	New Installation: Shop Motors	Shop Wiring	Power Plants	Misc'l Road Wiring	Maintenance: Shop Motors	Shop Wiring	Power Plants	Car Lts.	Head Lts.	Misc'l. Wiring.	Material: Carried in.	Segregated.	Elec'l Stockroom.
A. C. L.	EE	Advisory to Mechanical	MM	MM	MM	No Supv.	MM	MM	MM	EE	MM	No Supv..	GS	No	No
C. & O.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	Electrical stores.		
C. & N. W.	EE	Electrical	EE	EE	EE	EE	EE	EE	EE	EE	MM	EE	Electrical store.		
C. B. & Q.	EE	Engineering	EE	EE	—	EE	MM	MM	MM	Design EE Mntce.	MM	EE	GS	Yes	Attempted
C. G. W.	Chf. El.	Mechanical	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	GS	No	No
C. R. I. & P.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	—	—	—
Big. 4	EE	Mechanical	EE	EE	EE	EE	Locomotive shops und. Mas. Mech. Car shops under Car Department					,... ...	GS	No	Yes
D. & H.	EE, SE	Sig. & Telg.	EE	EE	EE	SE	EE	EE	EE	EE	EE	SE	—	—	—
D. L. & W.	EE	Elec. repts. to G. Mgr.	EE	EE	EE	EE	EE	EE	EE	MCB	EE	ES	GS	Yes	Yes
Erie	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	Electrical store.		
G. N.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	GS	Yes	Yes
I. C.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	Electrical store and general store		
L. I.			An Electrically operated road												
L. & N.	EE	Mechanical	EE	EE	EE	—	EE	EE	EE	EE	EE	—	Mech store	No	Elec'n
*M. C.			Divided between three heads										Electrical store.		
Mo. P.	EE	Telegraph	EE	EE	Mech S.	EE	MM	EE	MM	MM	MM	EE	GS	No	No
N. P.	ME	Mechanical	ME	ME	ME	ME	MM	MM	MM	MCB	MM	MM	GS	Yes	No
Penna. L., Pittsb.	EE	Mechanical	MM	MM	MM	—	MM	MM	MM	MM	MM	MM	—	—	—
Penna. L., N. W. Sy	EE	Mechanical	EE	EE	EE	—	EE	EE	EE	EE	EE	—	GS	—	—
P. & R.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	Electrical store		
P. & L. E.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	GS	Yes	Partly
†St. L. & S. F.	EE	Mechanical	EE	EE	EE	†	EE	EE	EE	EE	EE	†	GS	Yes	Yes
S. A. L.	EE	Mechanical	EE	EE	EE	EE	EE	EE	EE	EE	EE	EE	GS	No	No
Sou. P., Texas	Chf. El.	Mechanical	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	GS	Yes	Yes
Sou. Ry.	Sig. E & EE	Sig. & Elec.	S & EE	S & EE	S & EE	S & EE	MM	MM	MM	MM	MM	S & EE	Electrical store.		

*Work on Michigan Central is divided between Chief Electrician of Car Lighting and Locomotive Headlights, reporting to Superintendent Roebling, Stock and Superintendent Motive Power, Assistant Electrical Engineer in charge of all work in 3d rail zone, and Supervisor of Light and Power in charge of all work outside of 3d rail zone.

†On the 'Frisco, Superintendent Telegraph has two or three electricians who handle the smaller stations.

Note.—Although in many instances Shop Work is shown as under the jurisdiction of the Electrical Engineer, in most such cases the Shop Electricians report directly to the Master Mechanic and are carried on his payroll, but receive their instructions on electrical matters from the Electrical Engineer.

A little study of the table will show that while there is a decided lack of uniformity in the electrical organization of the different roads, one fact stands out conspicuously—that is, in the majority of cases the electrical engineer reports to the head of the mechanical department.

ELECTRIC WELDING is finding favor in Italy, and a recent exhibition was held to encourage the use of electricity instead of the oxy-acetylene flame. Italy has large quantities of hydroelectric power.

STRONGER RAILROAD POLE LINES

One of the most important matters acted upon by the Association of Railway Telegraph Superintendents at the annual meeting in Chicago was the adoption of rules for the specifications for railroad pole lines. These rules provide that such lines shall be designed under the proper assumptions of load of wind and ice for the territory in which they are located. A factor of safety of two is provided, except for poles within striking distance of the main track, in which case the factor of safety shall be three.

Up to the present time, telegraph and telephone pole lines have been built in accordance with individual experience or more or less "rules of thumb method." These methods have not given the results now required. The method of design as recommended by the association will apply recognized engineering principles to pole line construction. While the initial expense may be increased, a saving will be effected by less maintenance, the avoidance of delay and interference with railroad traffic by the failure of telegraph and telephone service.

The committee having the matter in hand believes that a factor of safety of two for new poles will generally be sufficient for new pole lines to insure continuity of service and a factor of safety of three should be used for new poles when located within striking distance of the tracks, where a failure would interfere with the running of trains as well as severing communication.

It is intended that the specifications shall also include a provision covering the safe maintenance of pole lines. Wooden poles shall be maintained to never fall below 60 per cent of the original strength when new, or for pole lines having a factor of safety of two when new the maintenance shall never fall below 1.2. Those located within striking distance of main tracks having a factor of safety of three shall be maintained to never fall below 1.8.

The Operation of Locomotive Turntables

Increase in Size of Locomotives Has Made Power Operated Turntables Imperative for Economy

By R. M. Gaston

LOCOMOTIVE roundhouses came into use when locomotives were all small and could easily be turned by hand on suitable turntables. The turntable served the double purpose of directing the locomotives into the stall in a selective manner, as well as making it easy to head them in the proper direction when they started to their trains.

A turntable can be moved efficiently when compared to a transfer table, which moves sideways in a straight line. This is mainly on account of the custom of balancing the engine and tender on a small compact center bearing. If the bearing is of the plain disc or lense type it is not over 24 inches in diameter. If it is of the roller nest type, it is not over 48 inches in diameter. Bearings of these dimensions do not travel very far in making a revolution and hence consume but little power. In case a turntable carries a portion of the load on the end trucks the power consumed is very greatly increased because the supporting rollers move so much farther in making a turn. Tables are very seldom intended to turn with any of the load on the end trucks.

The increase in size of the locomotives has made balancing on the old short tables impossible, but the railroads have frequently found it necessary to use short tables till longer ones could be installed. This, of course, requires much more power and any modern tractor installation should have reserve capacity to meet such conditions. The operation of turntables by power enables turntables to be used even when overloaded; a condition impossible to meet with hand operation.

The drawback with a center bearing turntable is the necessity for balancing. As the locomotives are not symmetrical, end to end, the turntable must be considerably longer than the locomotive. The conditions are at their worst when the tender contains neither coal nor water. Even with this handicap, this type of turntable is in almost universal use. Many tables have been built without rollers under the ends so that a balanced swinging condition is imperative.

This introductory explanation is necessary to show why turntables fail to operate with old types of tractors and why the electrical apparatus may not be at fault even if fuses blow. When a turntable bears on one or both ends while turning, the effort required to move it is increased a considerable but indefinite amount.

A Typical Turntable Installation on the Elgin, Joliet & Eastern Ry., Waukegan, Ill.

The old type of turntable with a locomotive of moderate size was turned easily with three or four men pushing on handles attached to the table ends. As the locomotives increased in size, the tables required more men, sometimes as many as 18 or 20. Keeping a crew night and day or even calling so many men away from other work for this kind of duty is impossible under modern conditions on purely a cost basis. Solutions of the difficulty have been attempted by the use of compressed air, steam, gasoline and electricity.

The relative importance of continuous turntable serv-

ice is apparent, because turntables cannot be installed in duplicate to serve any particular roundhouse. Furthermore, if a turntable cannot be operated when wanted the locomotives cannot reach their trains and in cold weather incoming locomotives cannot be protected from freezing when their fires die out. In case of turntable failure, trains cannot run on schedule and valuable property is subject to serious damage.

Several attempts were made to operate turntables by power before 1900, with more or less success. The early equipments were naturally home-made affairs and their builders had no extensive experience to guide them. The capacity of these machines seldom exceeded 5 horsepower and compressed air motors found extensive use. These outfits probably wasted as much air as they used, as it is difficult to deliver air efficiently to a revolving table.

Steam was not used on very many tables on account of the trouble and general nuisance caused by such a small isolated boiler plant.

Many single cylinder gasoline engines have been used, but the upkeep of engines and reversing gears has proved to be excessive. Skilled operators were scarce and the single-cylinder engine is poorly adapted for such a rigid drive.

Electric motors have been adopted as standard by practically all roads on account of the superior service rendered. The motors are geared to a single chilled iron drive wheel which makes contact on a circular rail near the side of the pit. The machinery is supported on a rigid steel frame which is hinged to the table. The ends of turntables always have a vertical motion of a few inches to permit balancing of their loads, so for this reason it is impractical to use more than one drive wheel, in fact, there is no need for any more. The two hinge connections and the drive wheel give three points of support for the machinery frame and if these points of support are sufficiently spread the frame will be quite stable under all operating conditions.

The machinery frame carries a hand brake and sand box, as well as controlling apparatus for the motor as necessary equipment. The operator is provided with a weather-proof cabin with electric lights and often a heater of some kind. This equipment is known as a turntable tractor and should be capable of carrying counter-weight to give it sufficient adhesion.

The turntable tractor is in every sense a mono-wheel electric locomotive. It will push or pull up to its limit of adhesion, if the motor is properly proportioned, and will wear notches in the circular rail if the driver spins will be worn on the driver if the brake is used too severely in one spot without moving the table. Also flat spots in making stops.

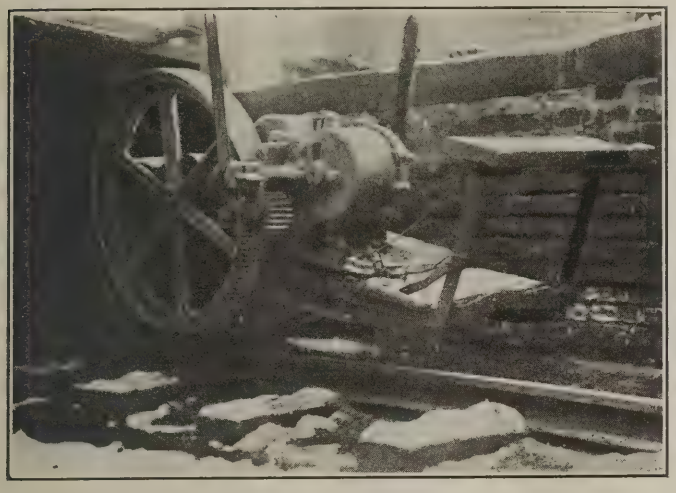
The tractor should have sufficient weight on driver to accelerate the load quickly even under adverse conditions. The more important turntables should naturally have a larger amount of reserve capacity if any distinction is made. The reserve capacity is needed to keep the turntable operating even if the turntable bearings become damaged or snow and ice become packed in the pit and rub against the table. Reserve capacity should be sufficient to move the table even if the locomotive is located slightly off of center, but it is doubtful if it is ever necessary to install sufficient reserve to operate the table with the locomotive in the extreme adverse position in reference to the table. In any case, the motor capacity should be sufficient to slide the driver, even with sand on rail, without blowing the fuses or doing any damage to the electrical equipment. This feature will reduce annoyance to a minimum.

Originally tractors were geared to operate a full revolution in about 40 seconds and later 60 seconds per revolution was common. As experience was gathered and turntables became longer and heavier, this time has been

First Twin Tractor Equipment Installed In 1910 on Pennsylvania Railroad at Meadows Shops, Jersey City

increased so that now many are geared to operate a revolution in 90 seconds to 120 seconds or more. There is seldom occasion to turn a locomotive a full revolution, in fact the average turn is not far from 45 degrees. With such short movements the ultimate speed is not so important as the ability to start and stop promptly.

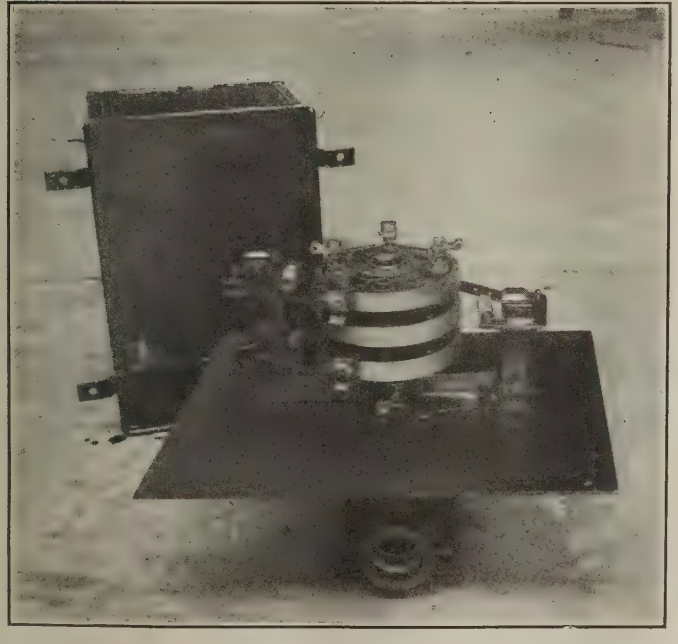
When direct current is used series wound motors are



An Obsolete Arrangement of Air Tractor. The Arms Reaching from Tractor to Table Are So Short That There Is an Excessive Rocking Action of Tractor Frame When the Turntable Teeters.

always selected on account of their superior torque capacity. The sizes run from 7½ to 20 h. p. When alternating current is used, the slip ring induction motor is the only type considered. The sizes run from 15 h. p. to 30 h. p. to give the same reserve torque capacity.

Reversing drum type controllers are usually used with



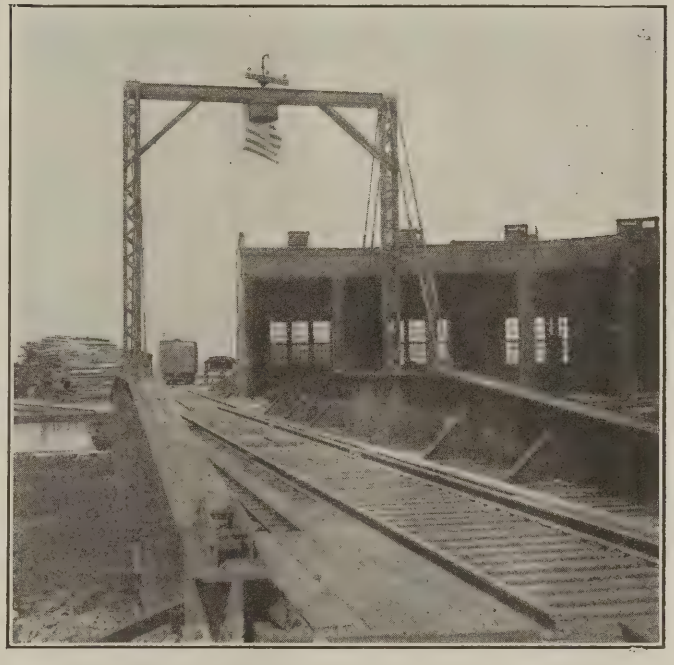
Close Up View of an Overhead Center Collector Designed for a Pipe Frame Support

cast-grid resistance, although carbon-tube controllers of the Allen-Bradley type are preferred by some roads. The important feature is to secure sufficient controller capacity to develop maximum torque long enough to turn an engine without damage and still retain sensitive control of the empty table so as to enable the operator to easily match up the rails. The same amount of flexibility of control is seldom met with in other motor installations.

Fuses are usually used for protection and when the entire equipment is properly proportioned give as good satisfaction as could be desired.

Electric connection to the revolving table is maintained by means of a set of slip rings mounted at the center either under the ties or over the track clearance. Collectors can be mounted in both locations if desired either for one or two power sources. The double installation insures against shut-downs in case of trouble in either the collector or their connections.

Electrical engineers have learned that a single transmission line cannot be depended to furnish continuous service for any considerable period, and railroad engineers do not expect continuous service from a locomotive. A turntable tractor like any other machine in constant use



One Example of Supporting Frame for Overhead Center Collector

requires repairs at times and in this case proper provision should be made for making repairs without interfering with the use of the turntable. Most turntables have periods of rest at some time during the day or week, which will permit minor repairs being made. If this is the case, a few spare parts carried in stock is all that is required.

Continuous operation of some turntables is so important that quite elaborate reserve and auxiliary equipments are justified. Some times a spare tractor completely assembled is stored near the turntable, which can be quickly placed in service with the assistance of a wrecking crane. If this loss of time must be avoided, a second tractor may be attached to the opposite end of the table. When two complete tractors are attached to a table, they can be wired to operate from one operator's cab so as to operate together when an extra reserve power is required. The Pennsylvania system, after very careful investigation, is installing quite a number of double equipments of this kind.

Another railroad has maintained several gasoline equipments on electrically equipped tables for reserve use only. This road is now contemplating the purchase of several additional equipments for the same purpose. Their present plans include four-cylinder engines with magneto ignition and enclosed reversing gears with hardened steel gears and ball bearings. If air cooled engines are used they will be as reliable as modern engineering can make them. Duplicate tractors of this type on a turntable would certainly compete with electric tractors and would be independent of outside power supply.

Hauling devices for handling dead engines and ash cars over the turntables are frequently used. In case of engines of moderate size the haulage device can be combined with the tractor so as to use the same motor. For heavy equipment it is better to use an independent machinery set, located at the center of the turntable. Such an equipment consists of a winding drum with motor gearing and brake mounted on brackets. With proper arrangement of sheaves, locomotives can be hauled into or out of any stall with comparative ease. This feature is considered valuable in case the roundhouse should be threatened with fire.

A heavy turntable can be operated for twenty-four hours with two or at the most three men if a tractor is used. If the table is busy, it will require the attention of from 15 to 40 men most of the time, so the economy is very evident. In fact, it seems almost criminal to operate a busy table with man-power, considering the labor shortage the country is experiencing at present. The operation of a turntable by power is necessary for rapid handling of locomotives. There are few other devices which will pay for themselves as quickly as a good turntable tractor.

Directions For Operating Electric Tractors

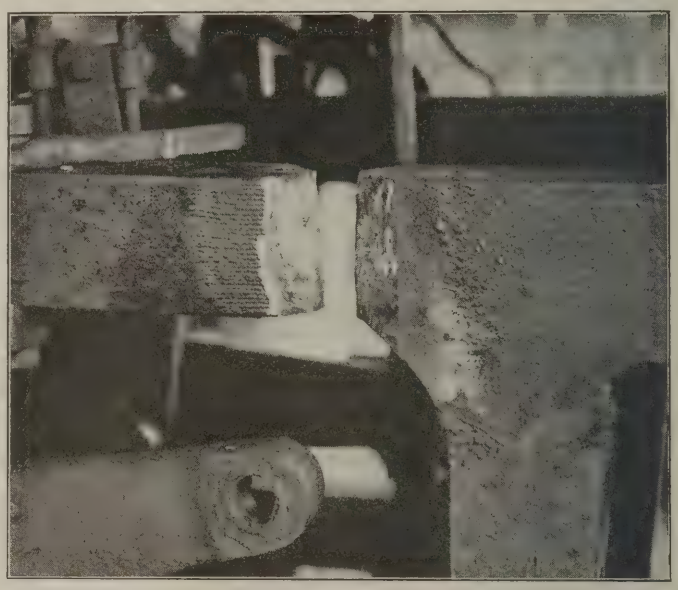
ALWAYS see that controller handle is in center before closing main switch.
Move controller handle ONLY ENOUGH to start the table at first but follow up as table speeds up.
After starting, run with controller handle CLEAR AROUND AGAINST STOP.
Shut off BEFORE you reach stopping place to let table coast and slow down before setting brake.
The brake is powerful. DO NOT PULL HARD on handle or the drive wheel will slide.
Sand rail ONCE a day all around.
Turn down grease cups one turn EVERY DAY on all machinery bearings.
Fill cups with GREASE when empty.
Pour THIN LIGHT YELLOW OIL in motor bearings once a month.
Keep motor commutator or rings CLEAN and renew brushes when worn.
Keep motor DRY.
KEEP ALL BOLTS TIGHT.
KEEP TURNTABLE CENTER AND END WHEELS PROPERLY OILED.

This Instruction Card Is Mounted in Each Operator's Cabin

SAVING MONEY BY ELECTRIC WELDING

Every day that the electric welder is used adds a definite and appreciable sum to the amount saved in making repairs by this machine. One of the principal uses for electric welding in railroad shops is found in the repair of broken engine frames. Broken frames are something that every railroad has to contend with more or less, and prior to the advent of electric welding the more common practice of removing the frame to the blacksmith shop was a decidedly costly operation. Not only was the amount of labor required by the old method very much greater, but the time that the engine was necessarily kept out of service was a very discouraging factor. Such breaks are now readily repaired in only a small fraction of the time formerly required and the welds made by the new process are giving entire satisfaction. The difference in the cost of making such welds by the old and the new process is so great that the saving effected by making a single repair will go a long way toward paying for a welding equipment.

Some interesting figures are here given showing the approximate saving in making a single weld on a Dela-



Broken Frame of a D., L. & W. Locomotive Ready To Be Welded.

ware, Lackawanna & Western locomotive at the Kingsland (N. J.) shops:

Engine—Class H-6 (superheat).
Type—4-6-0.
Cylinders—23 inches by 26 inches.
Engine and tender weight—349,500 pounds.
Tractive power—33,900 pounds.
Size of frame—5 inches by 6 inches. (Cast steel showing break at top rail, back of front jaw.)
Frame electric welded with Wilson welding outfit.

Cost of cutting frame and dressing for welding	$4.08
Cost of material used (incl. cutting frame)	2.52
Welding frame	17.00
Approximate cost of removing front wheel	52.85
Total	$76.45

No pre-heating required.
Approximate cost of removing frame and weld being made in blacksmith shop $500.00

When so great a saving can be made on a single weld it requires but little consideration to see that the electric welder has not only come to stay, but that its usefulness will be greatly extended in railroad maintenance.

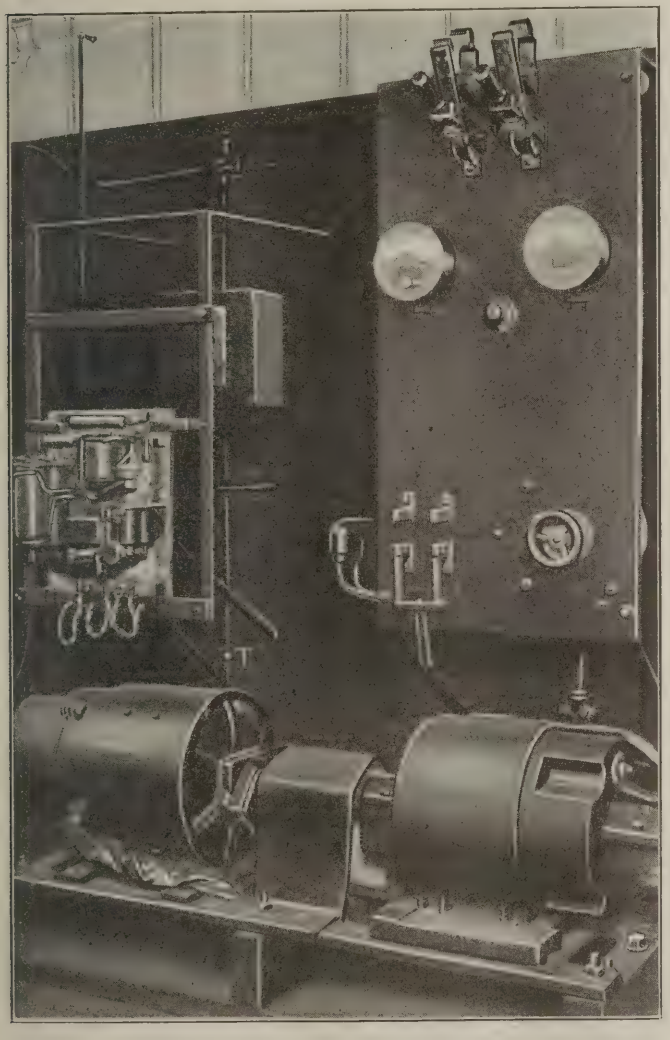
"Dickens Wrote About a Place he called 'The Circumlocution Office'," said a railroad lawyer returning to his hotel in Washington from a visit to the law division of the Railroad Administration, where he had been trying to get action on a compensation contract. "If he were alive today he would change the name of the place he wrote about and call it 'The Expedition office' and write a new story to fit the old title. And I know where he would lay the scene of his new story, but I'd better not say."—*Wall St. Journal.*

Car Lighting Regulator Testing Equipment

Past and Present Practice With Description of the New York Central Test Set at Chicago

By B. H. Ehringer

THE importance of properly maintaining, inspecting, testing and adjusting car lighting regulators should be considered seriously by all car lighting men since no electrical equipment for car lighting or any other service is perfect and it is liable to and does get out of adjustment. Parts are sometimes broken, lost or stolen and when replaced, of course, the proper test and adjustment should be made to make the apparatus function correctly. Battery trouble is frequently incidental to some failures in the regulations. Many other reasons, all of which are well known to car lighting men, could be mentioned, but the main point to bear in mind is the fact that regulating apparatus for car lighting service has been designed by the manufacturers to be the brains, so to speak, of the entire car lighting system. Regulators provide the necessary link between the source of power and the electric lamps in the cars and when properly cared for they perform their functions in an almost human manner. If, however, a derangement develops in any of the parts it is quite likely that the lighting service may be put out of commission or at least that it may become very poor. One thing is certain, a regulator cannot adjust itself. It requires an experienced person to adjust it.



General Arrangement of Testing Frame, Switchboard and Motor-Generator Set

Some failures in certain other types of apparatus can often be located by a thorough inspection of the parts. This, however, is not usually the case with car lighting regulators. When trouble develops in that type of apparatus it generally requires a service test of some kind, provided the apparatus has not been damaged to the full extent of its operating possibility.

Past Practice in Testing Equipment

When one looks back to the early days of car lighting it is interesting to recall the crude methods employed by many car lighting electricians who never used instruments in making tests, but who by some almost superhuman means could tell almost to the ampere the amount of current flowing in a circuit. They could also tell the operating voltage of automatic circuit breakers by the amount of noise they made in closing. One of the most extraordinary accomplishments of those pioneer electricians was their achievement of being able to tell the voltage furnished to electric lamps by their brilliancy. It is gratifying to note, however, that those methods have passed out of existence and that car lighting men are now using modern means and methods for testing equipment.

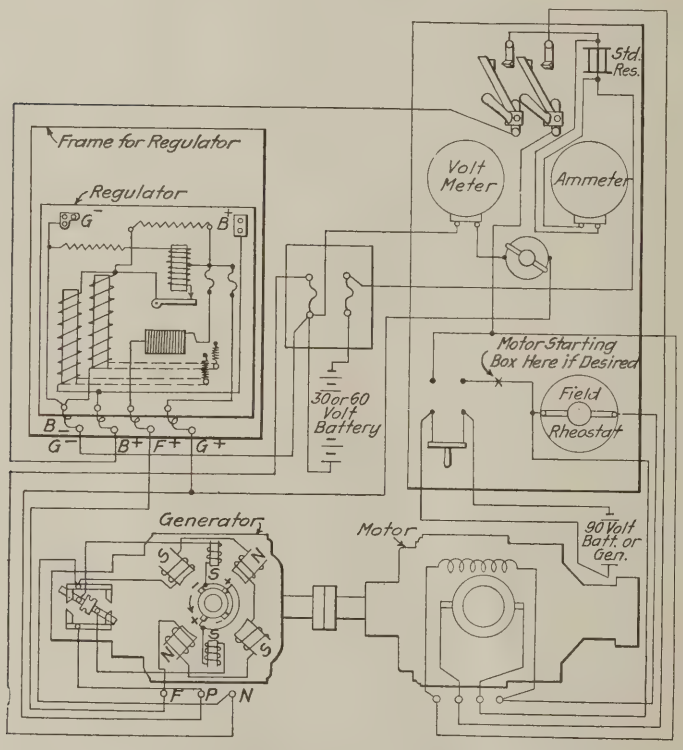
Present Practice in Testing Equipment

The importance of careful inspection, testing and adjusting car lighting regulators is becoming recognized as an essential feature in the proper care of lighting equipment and various means are used for making the necessary tests. Each scheme perhaps has many points worth considering and undoubtedly some schemes when employed under certain conditions give better results than others under the same conditions. A common method for which it is claimed very good results are obtained, is that of riding the cars and making tests and adjustments, using the necessary electrical instruments on the various circuits to determine the actual operating characteristics. Some of the objectionable features to this method are that this requires a larger organization of trained men, and that while the necessary tests and adjustments are being made the flickering of the lights is annoying to the passengers. It may also happen that when trouble is found to exist in the regulating system the inspectors are not equipped to make the necessary repairs because of the lack of facilities. It is also difficult to get satisfactory voltage and ampere readings because of the vibration of the moving train. Another method of testing regulators which has been used by

some roads is to operate the car lighting generator by means of a motor while the car is standing in the yard. This method is objectionable because it requires three or four men to handle the motor, which must be taken out of the shop on a truck. Even after the motor is placed under the car containing the regulator to be tested, it is a difficult matter to get the generator belted up properly without a considerable amount of slipping of the belt. After the tests are made the motor has to be carted back again to the shop. The entire procedure requires considerable time and several men which is objectionable inasmuch as there are other methods which will give as good or better results with an expenditure of less time and which require only the services of one man. One such scheme, which may be of interest to all car lighting men, has been developed and put into practice by the New York Central at its passenger car yard at Root street, Chicago.

The Regulator Test Set

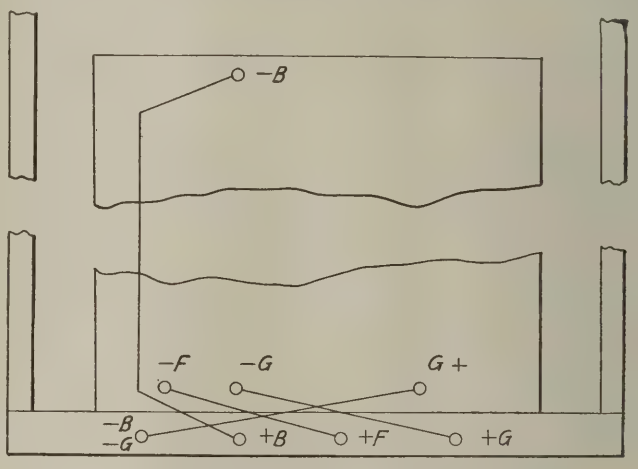
The equipment which is included in this regulator test set consists of a type "D" Consolidated generator direct-connected to a Moskowitz generator which is used as a motor. Adjacent to the motor generator set is a panel



Circuits for Testing Equipment With "Safety" Regulator on Test Frame

with a rheostat, switches and two meters; also a frame work made up of ⅜-inch by 1½-inch iron upon which can be mounted the regulator panels to be tested. The illustration shows a Safety regulator mounted and connected up on this frame work. All wiring leading to and from the switch panel and regulator frame is carried in an iron conduit. Directly back of the regulator frame is a junction box containing two fuses for the protection of some of the circuits. A complete wiring diagram for this equipment with connections to a Safety regulator mounted on the regulator frame are shown in another illustration. The armature and field of the motor are connected in parallel to a 90-volt circuit from the battery charging plant. A rheostat is used in the motor field circuit to permit a variation in the speed which is necessary in order to test or adjust a regulator properly. A motor-starting box could be included in the equipment on the switch panel if desired. The point of application of such a device is indicated by a cross (x) in the circuit illustration. Some trouble has been experienced in starting the motor used with this equipment because a starting box is not included.

The generator and regulator end of the outfit is wired the same as a Safety equipment with the following four wires terminating on a terminal board with loose flexible



Method of Connecting Gould Panel

ends at the bottom of the regulator panel frame: Negative generator, positive battery, positive field, and positive generator. The idea of the loose flexible leads is to permit a ready and quick means of connecting the various circuits to the regulator panels to be tested.

On the U. S. L. and Safety regulators these leads are connected to the corresponding terminal posts at the bottom of the regulator panel but when a Gould regulator is to be tested it is necessary to reverse the connections as shown in the wiring diagram for that type of regulator.

Preparing for Regulator Tests

When a regulator is to be tested it is disconnected from the car circuits and from the frame upon which it is mounted and brought into the shop where it is fastened to the testing frame by means of the two iron clamps shown in the illustration near the top of the regulator panel. If any parts are found to be missing or broken, new parts are installed and the entire regulator is thoroughly cleaned. All connections to terminal posts are inspected and any loose nuts or wires are tightened. The regulator is then ready for test.

To start the motor it is necessary to have all the rheostat resistance out of the circuit before any of the switches are closed. The right hand circuit breaker on the upper section of the panel is first closed followed by the closing of the double pole switch. The closing of this switch completes the circuit to the motor which will begin to rotate. The speed of the motor should be adjusted by means of the rheostat to drive the generator at such speed as will give the various voltages required in making the necessary test. In order to determine whether the generator is building up properly for the various speeds

of the motor the generator voltage should be noted on the voltmeter by closing the voltmeter switch on the switch panel.

Some of the Tests

Tests are made on voltage and current coils of those regulators equipped with such coils. Before any adjustment can be made on a defective regulator it is necessary to determine the operating voltage of the voltage coil and the operating current of the current coil. This can be accomplished by gradually increasing the speed of the generator and noting the voltage and current on the respective meters located on the switch board when the plungers on the coils begin to rise. If the voltage and current readings are not within the range for which the equipment has been designed it is necessary to make adjustments on the springs, weights or other adjusting parts until the proper readings are obtained. Whenever tests are made on Safety regulators equipped with springs on the levers used in connection with the carbon pile, the New York Central removes the springs and in their place lead weights are fastened on the plungers of the voltage and current coils. The average weight used on the potential coil is about 19 ounces and that on the current coil about 9 ounces. These lead weights, however, will vary somewhat, depending on the amount of adjustment necessary to get the proper voltage and current required. After the proper weights have been applied they are left in place and the old springs are discarded as it has been found that the springs do not give as much satisfaction as the lead weights, for the reason that a change in temperature affects the proper operation of the apparatus.

Tests are also made in a similar manner to permit the setting of automatic switches to operate at about one volt or a little more above the battery voltage of 32 or 64 volts, depending on the size of the battery used on the car to which the regulator belongs.

It must not be understood that these regulator tests are made in any way to include the generator on the car to which the regulator belongs. Generator tests are made separately from the tests on regulators when the latter are brought in to the shop.

Trials and Troubles of a Car Lighting Man

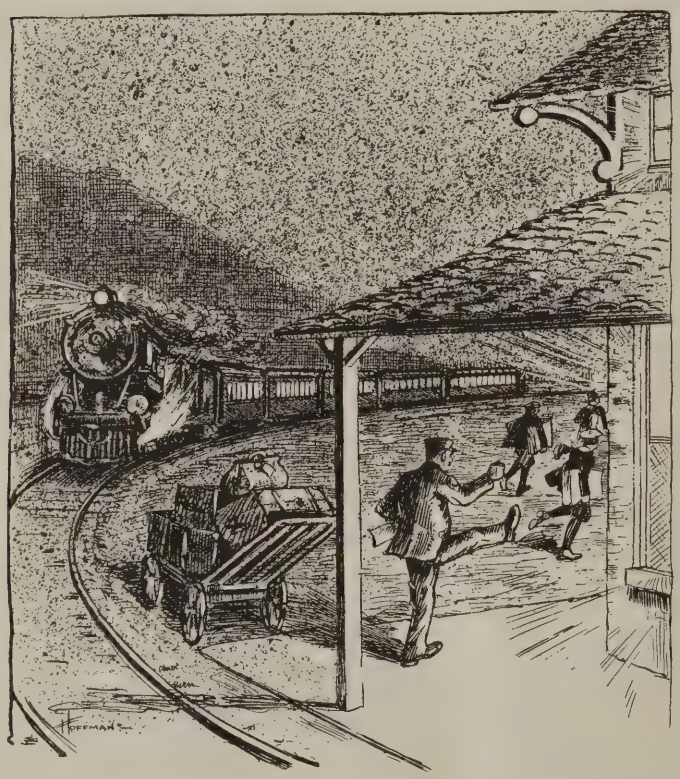
Hinkey Dee, the Electrical Expert, Consults the Yard Master's Clerk on an Important Matter

MY friend, if you don't know anything about car lightin' you will certainly believe me when I tell you the misfortunes and hard road me and me helper has had to plow. It isn't the technickle end that bothers me so much because any fellow can tell when the lights are burnin' in a car and when they are not, but it takes brains and gray matter to tell when the lights are not lit. I don't like to brag or talk about meself, but when the lights won't lite that's when I realized the value of my knowledge. Believe me, fellows, its no easy matter to get to be good like I am on axle lightin', but it seems to be that I am gifted with more brains than the average man. I know axle lightin' from the letter "a" to the letter "z," but to tell the truth I learned more about the lights in the cars from talkin' to the yardmasters, conductors and brakemen, and particularly with the yardmasters' clerks than anybody.

You know them fellows sure do know somethin' when it comes to car lightin' and its abomonible when you consider that they're not naturally gifted like me. How I first come to find it out was, one day a car backed into the yard with dim lights in it. It was a "straight storage" car No. 13, at least that's what they called it—yes, straight storage, that means something about the shape of the car, the number of seats, etc.—but being an electrician I have so much to remember I just can't be learning anything that I'm not supposed to know, so I just look after the lights and let the other fellow worry about the "straight storage." Well, soon as I saw the lights were dim I called up the yardmaster's office on the 'phone and told them I was Hinkey Dee, the man who knows all about the lights in the cars and that I wanted to see the yardmaster. They tried to kid me by sayin' that the yardmaster wasn't in and that I couldn't see him on the 'phone if he was cause the 'phone wasn't any peroscope, but they wouldn't kid me because being an electrician I know as much about telephone and peroscopes as anybody. So I said, "If the yardmaster isn't in, who am I talking to?" He replied, "I'm Pat Somebull, the yardmaster's clerk, what do you want?" By golly! I could see I was in bad for askin' for the yardmaster when the clerk was about, so I apologized because you know if you get in dutch with the yardmaster's clerk when your a car lighting electrician like me, the yardmaster won't move any cars or do you any favors like placing the cars to be charged, or anything. But soon as I apologized he said, "That's all right, Hinkey Dee, what's the trouble?" Then I told him that car No. 13 would have to be shopped for lights. Then's when I learned that yardmasters' clerks know something about car lightin'. He said, "What's the voltage of the lights on that car?" I told him the lights were very dim and down to 18 volts. Says he, "Now, let me figure." I waited ten minutes for him to figure and finally he asked, "How long will it take to fill that car?" I said, "Eight hours." "My goodness, old man, you'll have to do better than that, why can't you fill it faster than that?" I told him it can't be did, that if you would feed the battery too fast it would heat up and bust. Then he wanted to know why I couldn't feed it fast and fan it so as to keep it from getting overheated. I explained to him that when you fan a battery it blows the hot gas that comes from the covers and the terminals back into the cell and sulphates the plates, and in time would buckle the crates and snap the rollers. Then he said, "Hinkey Dee, my figures show that it won't be necessary to cut that car out, the number of the car is 13, the voltage is 18, it is three o'clock and the weather is cloudy; therefore, by multiplying the number of the car by the voltage, subtracting the date, adding

the number of the train and allowing for the weather conditions, will give you a result of 30, meaning that the car will have light for 30 miles. After the passengers read that long they'll be all read out and won't need any light, but to be on the safe side I'll wire the operator at each station to keep the newsboys away and out of sight when the train pulls in so the passengers can't buy any papers to read." Now, ain't that some knowledge! I work pretty steady all day, but when I get a few spare moments I don't lose any time in getting to the yardmaster's office so's I can learn something.

And say, maybe the conductors and brakemen don't have great ideas. I haven't said anything about this before to anybody because I didn't want someone else to get wise and invent it. One day Jimmy, the conductor on the shiftin' engine put me wise to a scheme he had doped out and I'll tell you it's a mighty good one, and when I get a little money saved up me and Jimmy's going to send it to the patent office at Washington. Now, I'll trust you not to tell anybody about it, but this is what Jimmy doped out. You know he sees us fellows plugging cables into the side of the cars so as to charge the batteries on the car and he knows how we kick when



The operator chases the newsboys away as the train approaches so the passengers in car No. 13 can't complain of not being able to read on account of poor light.

they shift the car several times after we have it plugged in. So one day he says, "Hinkey Dee, how long does it take to fill the battery on one of those cars?" I said, "Why, Jimmy, I can't tell you exactly, but when they are empty some times it takes eight hours." "My goodness, that's a long time to hold a car out of service," he said, "and Hinkey, I have an idea, instead of keeping the electricity at the power plant and taking so long to send it way out to the car and into the battery, suppose they had a big tank in each yard and would keep it filled with electricity at all times, then when a battery needed to be filled up all you'd have to do is open the tank, connect the hose to the car and fill it up. Just think of the time it would save." Well, I was so much impressed at Jimmy's new idea, that I just had to shake hands with Jimmy and tell him, "Jimmy, your a wonder, to think that I've been working around this place as an electrician all my life and you'd come along and put one over on me like this." So Jimmy said, "Look here, Hinkey, you have the knowledge of car lighting and all I have is a good level head, so if you'll agree I'll take you in on this new scheme of

As Jimmy the yard conductor pictured his wonderful scheme of having a tank of electricity always on tap

mine and we'll go 50-50." Well, I'm not bragging, but some day instead of Hinkey Dee, the car lighting man, and Jimmy, the yard conductor, it will be Hinkey Dee and Jimmy, the Great. But even then I'll never forget how much responsibility and the trouble a fellow has and the knowledge you have to have to be an electrician in car lighting on a railroad, like I am.

"THERE ARE THOSE WHO FEAR A BUSINESS DEPRESSION. The surest way to bring on a depression of business is to nurture fears and act hesitatingly. We now have a national financial system which is capable of meeting practically any situation that can arise, and we do not need to fear difficulties from that quarter. Our farmers have harvested an enormous crop, and the assurance of good prices, together with more plentiful labor, makes certain a heavy planting next year. The only thing needed to insure a year of great prosperity is a determination on the part of every business man, big and little, to go ahead with absolute confidence in the future.

"The business men of this country must see to it that employment is provided for our war workers and returning soldiers. We have shown our service stars and worn our Liberty Loan buttons with pride. Let us take equal pride in doing our share to make employment for the men who have worked and fought to win the war."—*Thomas A. Edison.*

Elements of Practical Electricity

A Series of Articles Prepared for the Benefit of the New Men in the Railroad Electrical Field

IX.—Armatures

THERE is perhaps no other part of a generator or motor that requires as much careful consideration in design and construction as the armature. It is this part of the machine that requires by far the major portion of workmanship of the better kind. The reason for this is that the armature is subjected to many stresses which are frequently in excess of those for which the machine was designed. When loads are placed upon a generator that are considerably above its greatest capacity, heavy currents flow through the armature windings, and if the design and construction of the machine are not rugged, this excessive current will eventually cause trouble to develop in a number of places. Most machines are designed, therefore, to carry heavy overloads for short

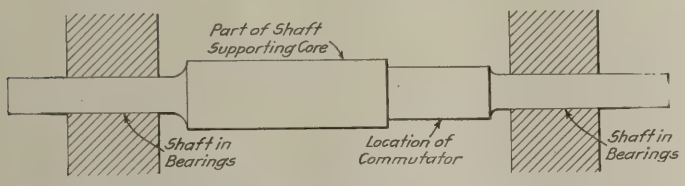


Fig. 1—Sketch Showing Diameters of Different Portions of an Armature Shaft

periods of time, and to carry partial overloads for longer periods. Inasmuch as the armature forms such an important part of the generator, a study of some of the parts which enter into its construction will be of interest.

The Armature Shaft

The armature shaft is usually made of a mild steel which is somewhat different from that used for other machinery. Since it is desirable to make the air gap between the armature core and the faces of the field poles as small as possible, it is very important that the spring of the shaft should be very slight. In any event, it should not exceed 0.008 of an inch at the face of the armature. If for any reason the armature is not exactly centered, there will be maintained a smaller air gap on one side of it than on the other. This condition causes a stronger attraction between the nearer pole face and the armature which still further aggravates the defect and may eventually result in the armature striking the pole face. To obviate any such condition as this, the general practice in the construction of an armature shaft, is to make the central portion of the shaft, that is, the part upon which the core is placed, of a larger diameter than the portion of the shaft within the bearings. In Fig. 1, the general proportions of an armature shaft are shown. No attempt has been made to supply dimensions to the diameters of the various portions of the shaft as any such figures would be suited only to a particular machine. The actual dimensions for an armature shaft of any given machine are determined by the use of formulæ and require considerable mathematical computation which would not be within the scope of this article. In general, it may be said, however, that the kilowatt capacity of any machine and the speed at which it is to operate are the two principal factors which determine the dimensions of the various parts of the shaft.

Laminations

Following up the construction of an armature, the next important point which calls for consideration is the core, upon which the windings are placed. The laminations which enter into the construction of an armature core may be of three different types. For small machines that are not subjected to heavy load it is not uncommon to design the core laminations similar to the ones shown in Fig. 2. These laminations are generally from 0.014 in. to 0.025 in. in thickness and even up to a diameter as great as 30 inches they are punched out of a single piece of sheet iron. It will be noted that each of these laminations or disks are notched at the center so that they may be firmly keyed to the armature shaft. It is desirable that the laminations, when assembled, do not make a clean contact with each other and for this reason a thin coating of iron oxide, or rust, is permitted to accumulate on each lamination before it is placed on the shaft. Occasionally a thin coating of water glass or Japan varnish is used, but this is not the general practice. The object of insulating the laminations from each other is to prevent the flow of eddy currents through the iron of the core. Inasmuch as the iron core revolves in magnetic field when

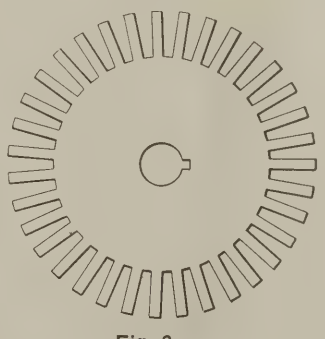


Fig. 2

Fig. 3

Fig. 2—Solid Lamination Used for Small Armatures.
Fig. 3—Lamination With Part of Center Punched Out to Allow Free Circulation of Air.

the generator is in operation, current would be generated in the core itself, in the same manner as in the conductors which are supported by the core, were it not for the insulation between the laminations.

Another type of lamination or punching which is commonly used is that shown in Fig. 3. It differs in construction from the type shown in Fig. 2, in that it is more open. The open construction allows a freer circulation of air, a thing which is very important with generators that are heavily loaded. Heavy currents flowing through

armature windings, together with the rapid reversal of magnetism in the revolving iron core, generate heat which, if no provision was made for its radiation, would in time become so excessive as to destroy the insulation of the armature conductors. For this reason specially constructed laminations having projecting ribs on their sides, are placed at regular intervals when the core is assembled. The open spaces which result from the ribbed laminations produce what is known as ventilating ducts. These ducts are open passageways from the interior of the core to the exterior, and while the armature is rotating air passes freely through them carrying off the heat developed and thus preventing the temperature of the machine from rising to a point where the insulation might be destroyed.

Armature teeth are constructed in a number of different ways. For smaller machines the type of tooth shown in Fig. 4 is commonly used. It will be noticed that the slot between the teeth in this type of construction has the same width at the bottom as at the top. This, of course, makes the tooth, itself, slightly narrower at the root. This difference in width of the tooth is not particularly noticeable, however, in the larger laminations, but it is always present in some degree, as it is essential that the space allotted to the wires have the same dimension at the bottom as at the top. On some of the larger

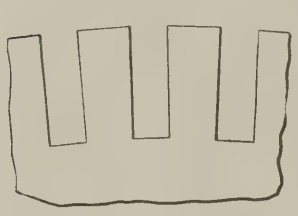


Fig. 4

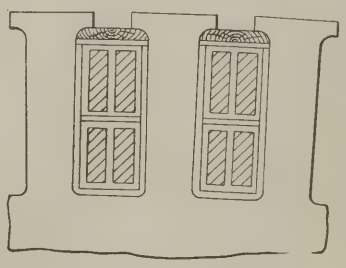


Fig. 5

Fig. 4—Type of Armature Tooth Commonly Used in Small Machines.

Fig. 5—Armature Teeth With Extended Tops. This Type Is Used Only in Larger Machines.

types of machines the teeth of the laminations are slightly extended at the top in order to permit of the insertions of a thin strip of wood or fiber for the purpose of holding the armature conductors firmly in place. Armature teeth of this kind are shown in Fig. 5.

The Spider

When generator armatures exceed 30 in. in diameter, the laminations are no longer made in one piece. The construction used in the larger types of machines is illustrated in Fig. 6. The laminations which make up the core are stamped out in sections so that when they are assembled they make a complete angular ring. In order to make as solid a construction as possible, the joints of the different laminated sections are staggered. In this type of construction the sectional laminations are supported by the arm of a cast iron wheel known as a spider, which in turn is secured to the armature shaft. In the particular case illustrated in Fig. 6, the laminations are held in place by a dovetailed projection fitting into a corresponding slot in the arm of the spider. The ventilating ducts are shown in the cross-sectional part of this sketch.

Commutator Construction

No other part of an armature requires as much care in its construction as the commutator. It is very important that the commutator should be carefully made so that it will be able to withstand the strain when the brush bearing surface is turned down in a lathe. Since the design for any particular armature necessitates a specific number of commutator bars the importance of having

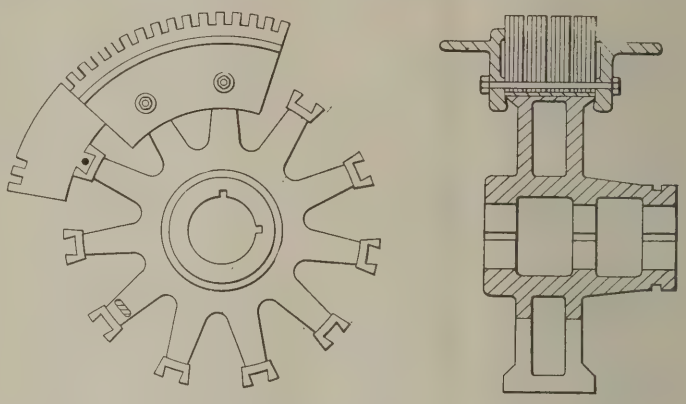


Fig. 6—Two Sketches Showing the General Construction of Armatures Which Exceed 30 Inches in Diameter.

each bar machined down to the proper size is readily apparent. Each segment is carefully tapered from the outer to the inner edge to within 0.001 of an inch of the correct size. The angle at which the segments taper will depend, of course, upon the diameter of the commutator and upon the number of segments, or bars in it. The sheets of mica which separate the segments are carefully selected in order that they may be of uniform thickness. In assembling the commutator segments a liberal use of shellac is made. After the segments have been assembled they are heated and the end ring is screwed or bolted up tight. The commutator is then cooled and further tightened. Throughout the heating, cooling and tightening process the iron shell upon which the segments are

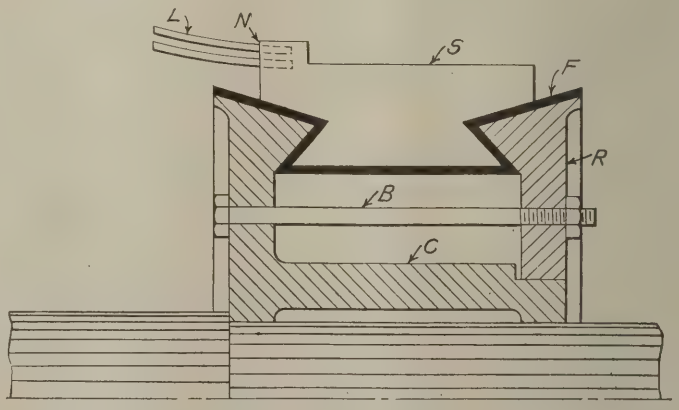


Fig 7—A Cross-sectional View of One Type of Commutator.

mounted is subjected to severe strains, and for this reason it is very important that the several parts be designed with ample strength.

Commutators are designed in a number of ways, but the sectional view of one type shown in Fig. 7 will serve to give a good idea of their general construction. The iron shell, *C*, in this figure is the supporting member of the commutator. The inner edge of this shell rests against the shoulder turned on the shaft and by

means of suitable keying the shell is held rigidly in place. An insulating fiber, *F*, separates the segments, *S*, from any electrical contact with the armature and the end ring, *R*, is drawn up tightly by a series of bolts, *B*, to hold the segments in place. It will be noted that

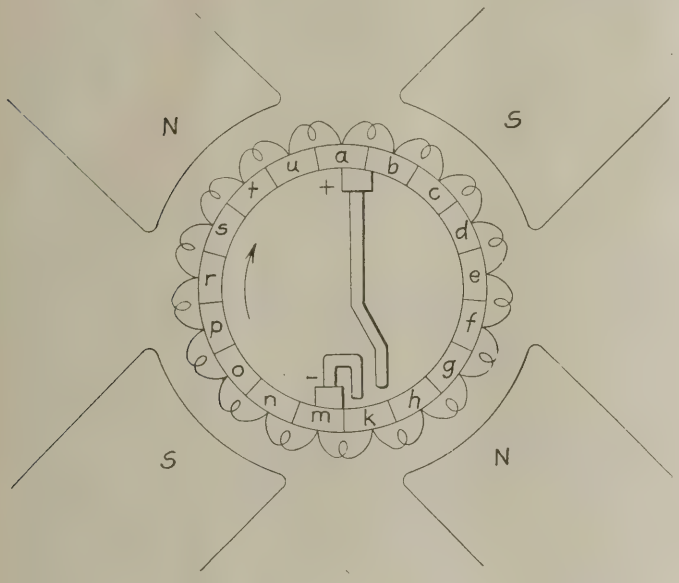


Fig. 8—Simplified Diagram of a Single Parallel Armature Winding.

the inner edge of the segments have a raised portion or neck, *N*, in which a slot is cut to receive the leads, *L*, of the armature windings which are usually soldered in place.

Under normal conditions commutators require very

Fig. 9—Complete Wiring Diagram of a Single Parallel Wound Armature.

little attention other than frequent inspection. The face of the commutator upon which the brushes bear should be kept smooth by the occasional application of a piece of No. 00 sandpaper. Very hard abrasives such as emery paper or carborundum should never be used either on the commutators or on the carbon brushes, on account of the continuous abrasive action of small particles of these substances which become imbedded in the brushes or commutator. Even when using sandpaper the brushes should be raised and before lowering them into position again the surface of the commutator should be carefully cleaned with a piece of canvas lubricated with a little vaseline or oil.

If the surface of the commutator becomes badly roughened through neglect, about the only remedy that can be applied is to remove the armature from the machine and have the commutator turned down in a lathe. With very large generators in which the armatures are extremely heavy the amount of work involved in removing an armature is so very great that the general practice with machines of this type is to turn the commutator down with the armature in place. It is seldom necessary to remove more than a very little of the commuta-

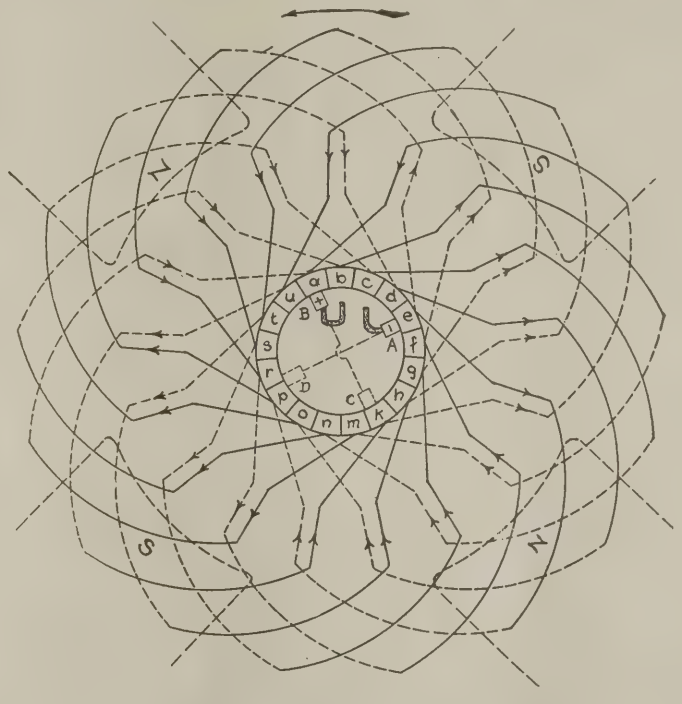


Fig. 10—Complete Wiring Diagram For a Series Wound Armature.

tor surface and a cutting tool such as used in the ordinary lathes is not generally required. For this purpose a truing device consisting of grinding stones is attached to one of the brush supports and by means of a suitable handle these stones are moved backward and forward across the face of the commutator while it is rotating. The surface is then finished off with No. 00 sandpaper while the machine is running. In all processes of this nature great care must be taken when the work is completed to remove all of the dust and grit that may have accumulated during the operation.

Armature Winding

There are many different ways in which an armature may be wound; in fact, the different methods of winding are so numerous that a large book would be required to illustrate and describe them all. In common practice, however, the windings used are the ones which are the least difficult to construct and yet which are able to sat-

isfactorily comply with all of the requirements of a modern generator. By a process of elimination the manufacturers of generators and motors have reduced the number of possible wiring methods down to two, which have been found practical and are in extensive use today. These two methods of armature winding are known as *series* windings and *parallel* windings.

At the best, armature winding diagrams are more or less complicated and for this reason only those of the simplest nature will be shown and described. In Fig. 8 a single parallel armature winding is illustrated. This drawing is diagrammatical inasmuch as it does not show the slots in the armature core that the windings lie in. The ends of any one armature coil terminate in adjacent segments and the complete coil itself is represented by a single loop. The complete wiring diagram for the same armature is shown in Fig. 9. It will be seen that this is much more complete than the one shown in Fig. 8, since the position of the wires in the slots of the core is indicated and all of the connections to the commutator segments are shown. Furthermore, the direction of current generated in the various parts of the windings when the armature is rotated in the direction indicated by the large arrow is clearly shown by the small arrows placed on the armature conductors at the point where they pass through the slots. In tracing the winding beginning at the segment *c* it will be seen that the coil enters the slot 1, and after leaving this slot at the end of the core opposite the commutator, it loops around and enters slot *5*, finally terminating on segment *d*. The circuit then continues from the segment *d* to the slot *2* and returns through slot *6* to segment *e*, etc. On account of the manner in which this winding is built up it is sometimes

Fig. 11—One Type of Formed Coil.

known as a lap winding. It will be observed that the small arrows on the winding indicate that the current is flowing away from the commutator in those slots located under the south poles, while in the slots under the north poles the current is flowing toward the commutator. In the design of a generator the number of poles, the number of slots in the armature core, the number of commutator segments and the position of the brushes all bear a fixed relation to each other. At the instant shown in the diagram two of the coils in slots *14* and *17* are in such relation to the north pole that the current in one side of each of them is flowing toward the commutator. One end of each of the coils in each slot terminates at the segment *t*, where the current is collected at the positive brush *B*. On the opposite side of the commutator two other coils terminating in segment *h* are supplying current to the brush *D*, which is also positive, and which is connected with the former positive brush by a heavy jumper wire. In like manner current is flowing from the negative brushes *A* and *C* into the segments which are in contact with them.

The complete wiring diagram for a series wound armature is shown in Fig. 10. At first inspection it might be thought that this diagram is the same as that shown in Fig. 9. As a matter of fact, it contains the same number of slots and commutator segments as the former diagram and the only difference in the wiring is that the ends of the coils are not attached to adjacent segments, but are connected to segments which are separated by a very nearly one-half of the commutator's circumference. For

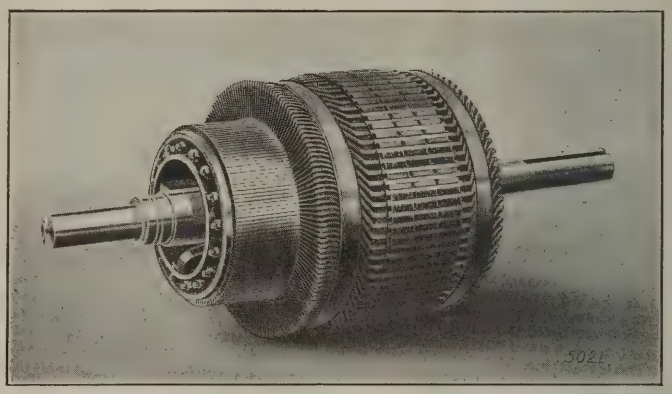


Fig. 12—A Complete Armature Ready for Service.

example, the coil which has one of its ends attached to segment *a* has the other end connected to segment *k*. The chief difference between the series-wound armature shown in Fig. 10 and the parallel-wound armature shown in Fig. 9 is that the former has twice the number of coils in series between the positive and negative brushes. This means that with all other things being equal the series-wound armature will develop twice the voltage of the parallel-wound machine. The total power output, however, in both machines is practically the same, for although the series-wound machine may develop twice the voltage, it is only capable of supplying one-half of the current of the parallel-wound generator.

As a general rule armatures are not wound by using a single strand of wire and threading it through the slots of the core. Although this method is used with very small armatures such as are found in fan motors or toy machines, a much more practical method is used in the construction of armatures in large generators. All of the wires which comprise a single coil are wound in the form of a loop upon a wooden frame or form. The dimensions of this form are such that when the coil is completed it will exactly fit into the proper slots of the armature core. After the proper number of wires have been wound in the form of a loop the coil is removed and the wires are carefully taped and given a coat of armature varnish or shellac. They are then baked at a moderate temperature to eliminate all moisture and to improve the quality of the insulation. The resulting product is a *formed* coil, such as shown in Fig. 11. When it reaches this stage it is ready to be placed in the slots of the armature core.

Fig. 12 is an excellent photograph of one type of armature. A careful inspection of this illustration will show very many of the details that have been described in this article.

Testing Lead Cells for Car Lighting Service

Simple and Novel Test Used by Western Road for Trying Out Various Types of Lead Storage Batteries

IN general, the lead storage battery has been looked upon for some time as a pretty thoroughly standardized piece of equipment. On the other hand experience has shown that some types of cells will last several times as long as others when subjected to the rigorous treatment they receive in car lighting service. Furthermore, it is desirable to know the actual efficiency of a battery and to know just what is going on inside. It must not be supposed from this that one make of cell is infinitely superior to all others, as one type of cell may be found better suited than another, made by

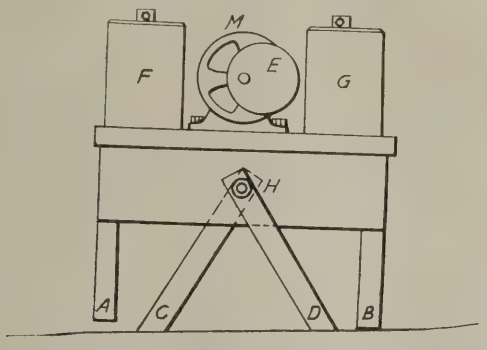


Fig. 1—End View of Table on Which Cells Were Tested

the same manufacturer. The fact remains, however, that the question of the proper cell must be decided by the user and for this reason, five different cells, all having the same ampere-hour rating, were purchased by the railroad and were subjected to the following described test.

Preliminaries

The cells, which for the sake of convenience we will designate as *A, B, C, D* and *E,* were first taken apart and careful dimensions and weights taken of each and

TABLE I

Dimensions in Inches

	Cell A	Cell B	Cell C	Cell D	Cell E
Height over all	19.5	19.5	18.56	17.5	19.0
Height of container	17.25	17.25	16.62	15.5	17.5
Breadth over all	10.75	10.75	11.5	10.0	12.0
Thickness over all	9.75	9.75	10.0	10.0	10.0
Breadth of container	9.75	9.75	10.0	10.0	10.25
Thickness of container	8.25	8.25	8.5	8.5	8.62
Cross section of lugs	.421	.421	.625	.421	.313
Height of plates (positive)	9.25	9.125	9.25	9.5	10.25
Height of plates (negative)	9.375	10.0	9.75	10.125	10.25
Width of plates (positive)	7.75	8.0	7.5	7.75	7.5
Width of plates (negative)	8.0	8.125	8.0	7.75	7.625
Thickness of plates (positive)	.50	.375	.375	.562	.438
Thickness of plates (negative)	.50	.37	.37	.31	.281
Number of plates (positive)	4	4	4	4	4
Number of plates (negative)	5	5	5	5	5
Burning height (positive)	10.50	10.75	11.0	11.5	11.0
Burning height (negative)	11.25	11.25	12.0	11.375	11.0
To top of lugs (positive)	14.75	14.75	14.5	14.5	14.375
To top of lugs (negative)	14.75	14.75	14.5	14.5	14.375
Cubical content of tank	764.0	764.0	807.0	780.0	866.0

every part, as shown in Tables I. and II. Particular stress was laid on getting the exact size and thickness of the plates in order to find just how much the plates would warp and grow during the test. All sediment was carefully cleaned out of the bottom of the tanks and the cells then reassembled. Notes were made of the various types of separators, covers, bushings and so forth, in each cell and a sufficient amount of electrolyte was added to cover the plates about half an inch. The electrolyte was weighed before it was added to each cell. The specific gravity was purposely started at a slightly

TABLE II

Weights in Pounds

	Cell A	Cell B	Cell C	Cell D	Cell E
Complete	245.0	245.0	125.0	122.25	134.25
Cover and bushings	1.25	1.25	1.25	.438	1.125
Sealing compound	.25	.25	.28	.10	.212
Glass cover support	.....	.....	.22	.....	.47
Wood separators	.....	.....	1.625	1.25	.....
Rubber separators	2.75	2.812	2.938	2.156	4.625
Rubber separators	.....	.688	.....	.....	.....
Sheet rubber insulators	1.062	1.062	.625	.594	.625
Positive element	38.0	30.25	37.75	39.5	38.75
Negative element	31.0	32.0	31.0	30.0	29.5
Porcelain supports	1.781	1.781	2.125	2.00	2.219
Container and electrolyte	98.75	98.75	47.20	48.20	47.80
Container wtihout electrolyte	85.50	85.50	21.00	28.25	26.75
Electrolyte	12.25	13.25	16.20	19.95	21.05

Note.—Cells A and B were in a double container.

reduced value as it was desired to complete the test without adding water and to keep the average specific gravity during test at approximately 1.2.

Equipment Used

In order to subject the batteries to vibration similar to, or somewhat greater than they would receive in

Fig. 2—Equipment in Use. The Tub in the Foreground Contains the Rheostat for Reducing the Motor Speed

actual service, a low heavy table was built such as is shown in Fig. 1. A hole was drilled in each end of the table and a heavy iron rod placed through the holes and extending the full length of the table was used as a bearing. Two extra legs, such as *C* and *D,* Fig. 1,

were provided for each end of the table. These extra legs were drilled as shown at H, to fit the iron rod. Long threads on each end of the rod allowed nuts and washers to be used to keep the legs in place. By driving the legs C and D toward each other along the floor the whole table was raised about half an inch and a slight effort would cause it to rock back and forth on H as a bearing.

The batteries to be tested were placed in positions F and G, Fig. 1, and a small motor, M, was bolted to the top of the table as shown. An eccentric, E, was fitted to one end of the motor shaft. This eccentric was about eight inches in diameter by one inch thick and was made of cast iron. The hole for the motor shaft was two

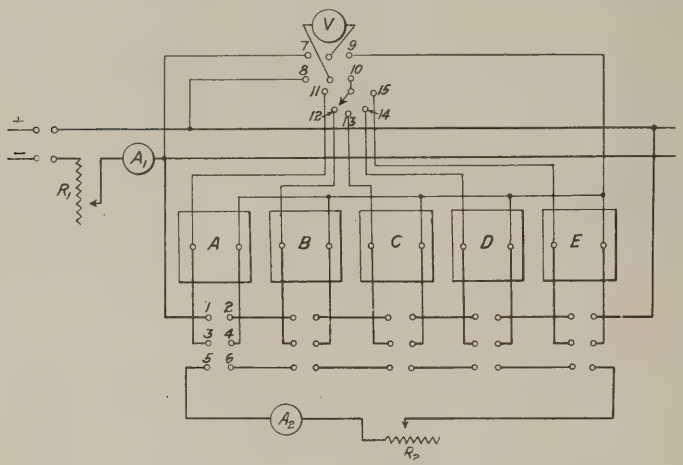


Fig. 3—Diagram of Wiring Used During the Test

inches off center. Knowing that the normal speed of the motor was 1,200 R. P. M. the shop men working near the test, all moved out when the electrician in charge first started the motor. Full voltage was applied to the motor field, and a greatly reduced voltage was applied to the armature by using a small water rheostat in the

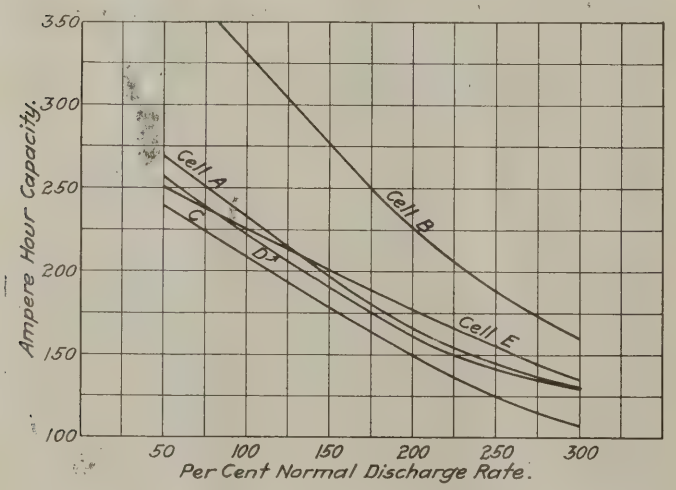


Fig. 4—Ampere Hour Capacity; Normal Rate Charge and Varying Rate Discharge

armature circuit. In this manner the motor speed was made about 200 R. P. M., which caused the table to rock back and forth about H, Fig. 1, as an axis, striking alternately on the legs A and B. This jarring was continued throughout the test. The table is shown in use in Fig. 2.

Wiring

The wiring scheme used is shown in Fig. 3. The cells were charged from the D. C. shop power through the resistance R_1, and were discharged through the resistance R_2. A water barrel resistance was used for R_1 and R_2 consisted of German silver resistance wire wound on two-inch pipe covered with asbestos paper. The shop

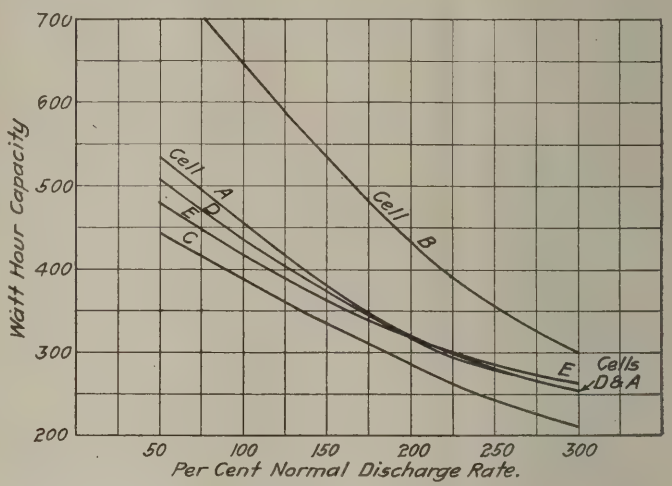


Fig. 5—Watt Hour Capacity; Normal Rate Charge and Varying Rate Discharge

voltage was subject to very little variation and a car lighting battery was used as an emergency supply of power in case of failure of the shop power. The current was measured by the ammeters A_1 and A_2. Voltage was measured by the voltmeter, V, and the five-point switch shown just below the voltmeter in Fig. 3.

A double point, double throw switch was provided for

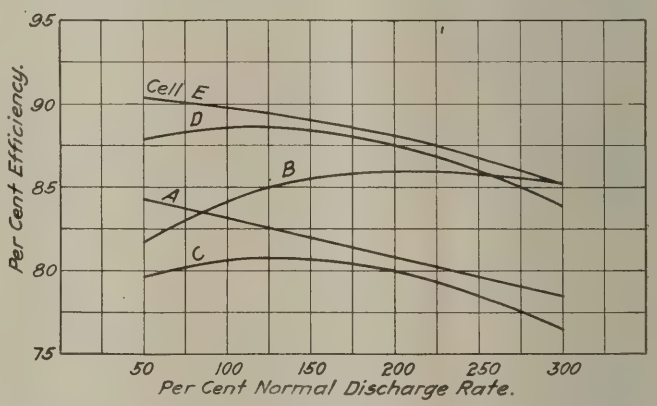


Fig. 6—Ampere Hour Efficiency; Normal Rate Charge and Varying Rate Discharge

each cell. As the batteries did not have the same capacity, some of them came to full charge conditions before others. Suppose, for example, that all the cells were being charged. All the double throw switches shown below each cell in Fig. 3, would then be in the *Up* position. Then suppose that cell A came to full charge condition first. The double throw switch would then be thrown down, which would put the cell on discharge through the resistance R_2 and a short circuiting bar would be placed across the contacts *1* and *2* to close the charging circuits. In the same way short circuiting bars were used across the lower contacts of the double

throw switches when less than five cells were on discharge. As the cells were charged and discharged in series there was little doubt but that they received very similar treatment.

Data

The cells under test were charged a number of times at normal rate and discharged between each charge at different rates varying from one-half to three times normal. Then they were charged at various rates and discharged after each charge at their normal rate. Samples of the data taken during these tests are shown in Tables III. and IV. While the cells were being charged or discharged at rates greater than normal, temperature readings of the electrolyte were taken with each reading of specific gravity.

After all of this data was taken and made up into a number of tables, such as III. and IV., these tables were boiled down and the results used to make Table V. From

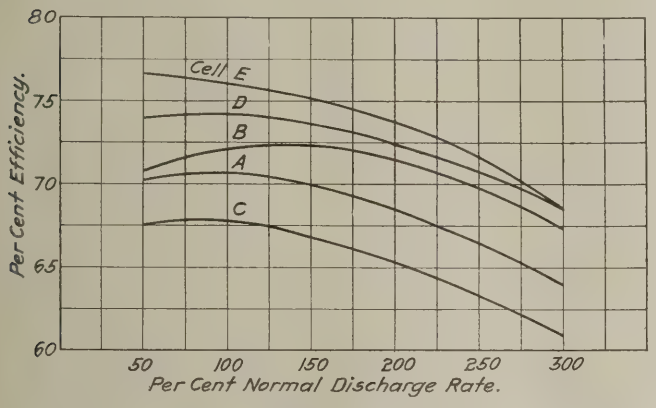


Fig. 7—Watt Hour Efficiency; Normal Rate Charge and Varying Rate Discharge

the data shown in the first-half of Table V., the curves shown in Figs. 4, 5, 6 and 7 were plotted. Similar curves were plotted from the second half of the data in Table V. Ampere hour efficiency was computed by dividing the ampere hour output by the ampere hour input, and watt hour efficiency was obtained by dividing the watt hour output by the watt hour input. It is interesting to note here that except for the half rate charges and discharges, all the data was taken and all the work done during and in preparation for the test, by one man.

After the test, weights and measurements were taken as before the test. The plates were carefully examined and the amount of warping measured and recorded. The electrolyte was removed and when weighed it was found that each of the cells had lost about one pound of electrolyte. The sediment was scraped out of the bottom of the tanks, carefully dried and then weighed on laboratory scales.

Considering 100 per cent as denoting an absence of warping and zero per cent as denoting a condition requiring repair, the condition of the plates in the different cells after the test, was as follows:

Cell A—80 per cent.
Cell B—80 per cent.
Cell C—85 per cent.
Cell D—90 per cent.
Cell E—100 per cent.

The amount and condition of sediment found in the bottom of each cell at the end of the test was as follows:

Cell A.—9.4 grams; dark brown in color; finely divided and smooth.

Cell B.—16.3 grams; light brown, full of lumps and granular.

Cell C.—10.3 grams, dark, reddish brown.

Cell D.—4.4 grams, light reddish brown. During the test the cover of the cell was broken by the jar, thus allowing the plates to move back and forth slightly with

TABLE III

Normal Rate Charge

	Cell A 25.5 Amps.		Cell B 25.5 Amps.		Cell C 25.5 Amps.		Cell D 25.5 Amps.		Cell E 25.5 Amps.	
Time	Volts	Sp. Gr.	Volts	Sp. Gr.	Volts	Sp. Gr.	Volts	Sp. Gr.	Volts	Sp. Gr.
7:00 A.M.	2.165	1.151	2.145	1.130	2.145	1.140	2.17	1.152	2.185	1.140
7:30	2.14	1.153	2.14	1.129	2.14	1.142	2.165	1.156	2.17	1.142
8:00	2.145	1.155	2.135	1.130	2.155	1.145	2.165	1.160	2.15	1.144
8:30	2.16	1.158	2.135	1.131	2.17	1.146	2.175	1.165	2.15	1.146
9:00	2.17	1.163	2.14	1.137	2.185	1.151	2.185	1.171	2.16	1.148
9:30	2.18	1.162	2.15	1.142	2.2	1.154	2.19	1.173	2.165	1.151
10:00	2.19	1.168	2.155	1.148	2.21	1.157	3.2	1.176	2.17	1.152
10:30	2.20	1.171	2.16	1.148	2.225	1.162	2.21	1.179	2.18	1.155
11:00	2.21	1.174	2.165	1.150	2.24	1.166	2.22	1.183	2.19	1.156
11:30	2.22	1.177	2.175	1.150	2.25	1.170	2.23	1.185	2.2	1.159
12:00	2.225	1.179	2.18	1.152	2.28	1.171	2.24	1.188	2.205	1.161
12:30 P.M.	2.235	1.183	2.18	1.155	2.28	1.172	2.28	1.187	2.215	1.163
1:00	2.24	1.184	2.18	1.157	2.29	1.175	2.28	1.190	2.23	1.165
1:30	2.25	1.189	2.19	1.161	2.33	1.180	2.29	1.192	2.24	1.164
2:00	2.275	1.191	2.195	1.166	2.4	1.184	2.34	1.197	2.255	1.170
2:30	2.28	1.195	2.2	1.170	2.51	1.188	2.45	1.202	2.27	1.172
3:00	2.29	1.194	2.21	1.172	2.595	1.191	2.61	1.204	2.29	1.175
3:30	2.315	1.199	2.215	1.176	2.625	1.196	2.63	1.206	2.345	1.181
3:45	.....	.....	.....	.....	2.635	1.201	.....	.....	.....	.....
3:50	.....	.....	.....	.....	2.635	1.207	.....	.....	.....	.....
3:55	.....	.....	.....	.....	2.64	1.206	.....	.....	.....	.....
4:00	2.415	1.202	2.225	1.179	2.64	1.206	2.65	1.204	2.49	1.187
4:05	.....	.....	.....	.....	2.645	1.203	2.65	1.203	.....	.....
4:10	.....	.....	.....	.....	2.645	1.204	2.655	1.203	.....	.....
4:15	.....	.....	.....	.....	2.645	1.202	2.655	1.203	.....	.....
4:20	.....	.....	.....	.....	2.645	1.202	2.66	1.203	.....	.....
4:30	2.56	1.209	2.23	1.178	Off at 4:20 P.M.		2.66	1.204	2.535	1.197
4:35	.....	.....	.....	.....	.....	.....	2.66	1.205	.....	.....
4:45	.....	.....	.....	.....	.....	.....	Off at 4:35 P.M.		2.54	1.199
4:50	.....	.....	.....	.....	.....	.....	.....	.....	2.54	1.201
4:55	.....	.....	.....	.....	.....	.....	.....	.....	2.545	1.202
5:00	2.585	1.205	2.24	1.182	.....	.....	.....	.....	2.55	1.203
5:05	.....	.....	.....	.....	.....	.....	.....	.....	2.55	1.203
5:10	.....	.....	.....	.....	.....	.....	.....	.....	2.55	1.203
5:15	2.585	1.205	.....	.....	.....	.....	.....	.....	2.55	1.203
5:20	2.59	1.203	.....	.....	.....	.....	.....	.....	Off at 5:15 P.M.	
5:25	2.59	1.205	.....	.....	.....	.....	.....	.....	.....	.....
5:30	2.59	1.205	2.28	1.191	.....	.....	.....	.....	.....	.....
5:35	2.595	1.205	.....	.....	.....	.....	.....	.....	.....	.....
5:40	2.6	1.204	.....	.....	.....	.....	.....	.....	.....	.....
5:45	2.6	1.203	.....	.....	.....	.....	.....	.....	.....	.....
5:50	2.6	1,202	.....	.....	.....	.....	.....	.....	.....	.....
5:55	2.6	1.202	.....	.....	.....	.....	.....	.....	.....	.....
7:30	Off at 5:55 P.M.		2.4	1.200	.....	.....	.....	.....	.....	.....
8:00	.....	.....	2.48	1.200	.....	.....	.....	.....	.....	.....
8:30	.....	.....	2.56	1.212	.....	.....	.....	.....	.....	.....
9:00	.....	.....	2.59	1.217	.....	.....	.....	.....	.....	.....
9:30	.....	.....	2.605	1.206	.....	.....	.....	.....	.....	.....
9:35	.....	.....	2.605	1.204	.....	.....	.....	.....	.....	.....
9:40	.....	.....	2.61	1.212	.....	.....	.....	.....	.....	.....
9:45	.....	.....	2.61	1.212	.....	.....	.....	.....	.....	.....
9:50	.....	.....	2.61	1.213	.....	.....	.....	.....	.....	.....
9:55	.....	.....	2.61	1.213	.....	.....	.....	.....	.....	.....
			Off at 9:55 P.M.							
Total Amp. Hours	278.5		380.5		238.0		239.5		256.0	
Total Watt Hours	634.8		861.3		550.9		554.5		577.7	

the swing of the table. This caused the sediment to contain particles of crumbled separator.

Cell E.—1.9 grams, dark reddish brown.

Conclusion

From the data taken during the test and from the data obtained by taking weights and measurements, the following conclusions were drawn:

Cell A.—High ampere and watt hour capacity per cell and per pound of cell. Low efficiency. Low grid strength allowing plates to bend easily. Type of grid construction seems to permit warping. Cover difficult to remove because of design of lugs and rubber bushings. Considerable amount of sediment tends to indicate short life.

Cell B.—Highest watt and ampere hour capacity with both varying charge and varying discharge. High capacity per pound of cell. High watt hour efficiency. Low grid strength allowing plates to bend easily. Type of grid construction seems to permit warping. Cover difficult to remove because of design of lugs and rubber bushings. Largest amount of sediment indicative of short life.

Cell C.—Good mechanical construction. Low ampere and watt hour capacity per cell and per pound of cell. Low efficiency. Type of grid construction seems to permit warping. Large amount of sediment seems to indicate short life.

Cell D.—High watt and ampere hour capacity per pound of cell. Small amount of sediment indicative of long life. High watt and ampere hour efficiency. Little warping of plates. Comparatively low watt and ampere hour capacity. Cheap mechanical construction throughout, container not equipped with skids, rollers or spacers and cover and bushings not sufficiently rugged for railroad service.

TABLE IV

Normal Rate Discharge

Time	Cell A 25.5 Amps. Volts	Cell A Sp. Gr.	Cell B 25.5 Amps. Volts	Cell B Sp. Gr.	Cell C 25.5 Amps. Volts	Cell C Sp. Gr.	Cell D 25.5 Amps. Volts	Cell D Sp. Gr.	Cell E 25.5 Amps. Volts	Cell E Sp. Gr.
7:00 A.M.	2.00	1.217	1.98	1.211	1.98	1.200	2.01	1.203	2.00	1.204
7:30	1.995	1.211	1.99	1.208	1.98	1.195	2.00	1.201	2.00	1.200
8:00	1.995	1.206	1.99	1.205	1.98	1.190	2.00	1.199	2.00	1.196
8:30	1.99	1.202	1.99	1.203	1.975	1.188	1.995	1.196	1.995	1.192
9:00	1.99	1.198	1.99	1.199	1.975	1.185	1.99	1.192	1.995	1.187
9:30	1.985	1.193	1.985	1.197	1.97	1.184	1.99	1.189	1.99	1.184
10:00	1.98	1.187	1.985	1.193	1.97	1.183	1.985	1.185	1.985	1.188
10:30	1.98	1.183	1.98	1.189	1.96	1.180	1.98	1.180	1.98	1.178
11:00	1.975	1.180	1.975	1.184	1.96	1.171	1.98	1.177	1.97	1.174
11:30	1.97	1.176	1.97	1.181	1.95	1.164	1.97	1.176	1.97	1.170
12:00	1.96	1.173	1.965	1.177	1.945	1.159	1.97	1.174	1.96	1.167
12:30 P.M.	1.955	1.170	1.96	1.173	1.935	1.152	1.96	1.171	1.95	1.164
1:00	1.945	1.169	1.96	1.171	1.92	1.150	1.95	1.167	1.945	1.160
1:30	1.935	1.166	1.95	1.169	1.895	1.148	1.94	1.163	1.93	1.157
2:00	1.92	1.163	1.945	1.167	1.86	1.147	1.925	1.160	1.92	1.155
2:30	1.90	1.161	1.94	1.166	1.77	1.146	1.9	1.158	1.9	1.153
3:00	1.88	1.159	1.93	1.163	Off at 2:30 P.M.		1.87	1.159	1.88	1.151
3:15	.....	.....	.....	.....	.....	.....	1.845	1.159	1.865	1.150
3:20	.....	.....	.....	.....	.....	.....	1.835	1.158	1.855	1.149
3:25	.....	.....	.....	.....	.....	.....	1.82	1.157	1.85	1.140
3:30	1.84	1.156	1.925	1.163	.....	.....	1.805	1.154	1.835	1.144
3:35	.....	.....	.....	.....	.....	.....	1.785	1.151	1.82	1.144
3:40	1.82	1.153	.....	.....	.....	.....	Off at 3:35 P.M.		1.805	1.145
3:45	.....	.....	.....	.....	.....	.....	.....	.....	1.785	1.143
3:50	1.79	1.150	.....	.....	.....	.....	.....	.....	Off at 3:45 P.M.	
	Off at 3:50 P.M.									
4:00	.....	.....	1.92	1.162	.....	.....	.....	.....	.....	.....
4:30	.....	.....	1.91	1.161	.....	.....	.....	.....	.....	.....
5:00	.....	.....	1.90	1.158	.....	.....	.....	.....	.....	.....
5:30	.....	.....	1.89	1.155	.....	.....	.....	.....	.....	.....
6:00	.....	.....	1.88	1.153	.....	.....	.....	.....	.....	.....
6:30	.....	.....	1.86	1.151	.....	.....	.....	.....	.....	.....
7:00	.....	.....	1.94	1.148	.....	.....	.....	.....	.....	.....
7:30	.....	.....	1.825	1.144	.....	.....	.....	.....	.....	.....
8:00	.....	.....	1.80	1.140	.....	.....	.....	.....	.....	.....
			Off at 8:00 P.M.							
Total Amp. Hours	220.7		331.5		191.4		214.5		223.5	
Total Watt Hours	431.5		642.0		371.8		420.1		436.1	

Cell E.—High ampere and watt hour capacity. High watt hour efficiency. Most uniform watt hour efficiency with varying rate discharge. Excellent mechanical construction throughout, *i. e.,* cover has greatest mechanical strength, lugs and rubber bushings have best design allowing removal without damage, single separators strong and well made, plates fit best in container, porcelain support will not fall out when solution is poured out of tank and will not slip to one side and get in way of the sheet rubber tank insulators when cell is reassembled after cleaning. Plates show no warping. Smallest amount of sediment indicative of greatest life. Comparatively low capacity per pound of cell. Pasted type negative may be injured by reversal of current. Groove in cover a little too deep to allow easy removal of cover.

The reader has by now undoubtedly drawn his own conclusions as to which one of the five cells is best adapted for car lighting service. As a point of interest, however, it may be said that the buyers for the railroad chose *Cell E* as the one best suited, but also bought several sets of the *B* type of battery. The *B* type gave excellent service at the start, but inside of four months they began to cause serious trouble and in six months all of them were discarded. All of the *E* type of cell have given excellent satisfaction and up to the present time have shown no evidence of any depreciation.

TABLE V

Efficiency and Capacity

Cell	Per Cent Normal Charge	Per Cent Normal Discharge	Amp. Hr. Capacity	Watt Hr. Capacity	Amp. Hr. Efficiency	Watt Hr. Efficiency
A.....	100	100	233.2	455.5	79.9	68.0
B.....	100	100	333.5	645.0	85.2	72.6
C.....	100	100	206.0	401.0	80.6	67.8
D.....	100	100	233.4	456.0	88.5	74.2
E.....	100	100	231.0	453.0	87.9	76.0
A.....	100	50	271.0	535.0	86.1	73.9
B.....	100	50	360.0	710.0	80.7	70.1
C.....	100	50	219.0	431.0	79.2	67.1
D.....	100	50	258.0	509.0	87.8	74.1
E.....	100	50	247.5	492.0	90.3	76.6
A.....	100	200	166.7	320.7	82.4	68.6
B.....	100	200	226.5	433.6	86.6	72.3
C.....	100	200	150.3	285.9	80.3	64.9
D.....	100	200	162.5	311.0	87.5	72.5
E.....	100	200	166.7	317.6	88.1	73.8
A.....	100	300	131.3	248.0	78.0	63.9
B.....	100	300	160.5	300.5	83.8	68.6
C.....	100	300	117.0	219.5	76.4	60.9
D.....	100	300	131.3	248.0	83.9	68.5
E.....	100	300	134.9	253.5	85.2	70.7
A.....	50	100	221.0	431.7	85.6	75.2
B.....	50	100	333.5	646.8	89.3	78.6
C.....	50	100	187.0	303.5	74.2	63.3
D.....	50	100	214.5	419.0	93.2	81.5
E.....	50	100	214.8	419.0	94.6	84.1
A.....	200	100	223.0	435.9	83.3	68.0
B.....	200	100	325.3	630.0	87.8	72.5
C.....	200	100	191.3	372.4	76.2	60.2
D.....	200	100	212.5	415.6	90.8	72.9
E.....	200	100	225.5	439.7	83.0	68.5
A.....	300	100	220.7	431.5	81.0	64.3
B.....	300	100	331.5	642.0	85.8	68.7
C.....	300	100	191.4	371.8	77.5	60.2
D.....	300	100	214.5	420.1	86.7	68.1
E.....	300	100	223.5	436.1	80.5	64.9

SELECTION OF WELDING EQUIPMENT*

Few things electrical have in so short a period of time created such wide-spread interest as that of arc welding. Engineers having to do with steel products, in whatever form produced or in whatever way employed, have investigated its uses not only as a building agent when applied to new material but as a reclaiming agent for worn or broken parts. In both cases its possibilities as a means of greatly increasing output and in saving otherwise useless parts at a small fraction of their original or replacement value has proved astounding.

Out of these investigations have grown several systems of arc welding that may be designated as constant potential, constant energy, alternating current.

To exploit these is the duty of the sales department and the measure of its success depends upon the quality of service rendered. Service at all times

*From an Article by J. W. Ham, in the General Electric Review, December, 1918.

is important and in times such as these it is a positive virtue.

The difficulties of giving service are perhaps not fully appreciated. Where so many systems have been called for and where so many individual ideas have to be met, the problems of the manufacturer become multiplied. It is only necessary to consider the following table to see the amount of material that would have to be carried to insure prompt deliveries.

System	Amp. Capacity	Drive: D-c. Volts	Drive: A-c. 3-phase, Volts	Combinations
Constant potential	400	230	All	6
	500	230	All	6
	600	230	All	6
	800	230	All	6
	1,000	230	All	6
	150	125		1
Constant energy	(2) 150-2 man	230	220/440	3
	(3) 150-3 man	230	220/440	3
	(4) 150-4 man	230	220/440	3
Alternating current	Various			3
			Total.....	43

We were asked to conserve food, fuel and material that the great war might be won. We subscribed to those conditions whole-heartedly, not passively, but actively. One form of our effort was to make possible the salvaging of old parts and defective new ones so that they need not be scrapped.

The German ships in various United States ports were thought to be beyond repair except by replacing damaged machinery with new. The question of cost was not so vital as that of speed in getting the ships into service. What was actually accomplished by means of the electric arc is a matter of record.

During the period of freight congestion and bad weather last winter, when locomotives were in unprecedented demand, an engine was run into the repair shop with slid flat spots on each of the eight driving wheels, and orders were issued to return it ready for service in record time. In three hours repairs had been completed by means of the electric arc (to have put on new tires would have required three to four days) and the locomotive was out on the road faithfully serving Uncle Sam. Many other achievements as remarkable as these have been obtained.

It would seem that having demonstrated the success of arc welding for a given line of work, others similarly engaged would be keen to take advantage of it; but that is true only in part, possibly because this is a "show me" age. Like William Tell, we shoot off the apple, but unlike him, we have to go on shooting off the whole orchard. If a railroad in one locality employs the electric arc to its decided advantage, why should not every railroad in the country profit in like manner? If a scheme were devised whereby half the ashes shaken through the furnace grates in our dwelling houses could be reclaimed and turned into fuel "good as new" and at a small percentage of the first cost, would we not embrace the opportunity of conserving fuel and at the same time saving money?

When it becomes apparent to the investigator of arc welding possibilities that the process fulfills his requirements, the question of what system to employ confronts him; salesmen are on the job to tell him about their particular specialties. He is informed that the real secret of welding is having the proper electrode (the salesman's special kind); it must be covered or bare, as the case may be, and contain certain unnamed ingredients. The merits of the direct current system are extolled. Alternating current outfits are advocated by others, it being claimed that they bite deeper and weld if the arc is held. The prospective buyer retires with a headache to think it over.

There is no mystery about arc welding. It is being done with all sorts of outfits and many varieties of electrodes. It can even be done from power lines with resistance in series with the arc. But these systems differ widely in essentials, just as in the case of automobiles. We can buy a cheap car or an expensive car, and in either event get about what we pay for; the striking difference, however, being that the low-priced car, in addition to having low initial cost, operates at low maintenance and high mileage per gallon of fuel consumed; while in the lowest first-cost arc welding system, i. e., one taking power direct from supply line through resistance, the maintenance is small but the results are poor and the cost of operation out of all proportion to the power really required. What is equally important to the purchaser and the power company, is the effect on the power system of unsuitably appointed equipments, such as alternating current welding outfits of low power factor without condensers.

The arc welding set must pay its way. It must earn dividends and conserve materials, and when properly selected and applied does both of these things to a degree quite gratifying. To the discriminating purchaser it is not sufficient merely to know that an outfit will make a weld, he wants to know if it is the best weld that can be made, if it can be made in the shortest possible time, and whether the ratio between cost of the entire system to the savings effected is the lowest obtainable. He doubtless will, if the work is of sufficient magnitude to warrant, establish a welding department with a trained arc welding man in charge, and see that this department stands on its own feet. By so doing he places responsibility on a man who knows what to do and how to do it—a friend rather than a foe of the system. He will, other things being anything like equal, respect the opinion of the operator in the selection of the system to be employed, because it is better to provide a man with tools he is familiar with and prefers to use, rather than to force him to use something with which he is unfamiliar.

Obviously, the purchaser wishes to know that the companies he is dealing with are reliable and responsible, that the experience back of the salesman is sufficient to warrant faith in his product. It is important to know the amount of power required per operator and whether drawing the needed amount from his own lines or from those of the power company will interfere with the system, and if so to what extent, and what, if any, additional apparatus will be needed to correct the trouble. Having determined these things to his satisfaction, he can install his arc-welding system with a degree of assurance that there will be a decided saving in time, men, and money, and a genuine conservation of materials.

PRACTICAL STUNTS

A Lead Reclaiming Furnace

By Carl E. Schwanz, Car Lighting Foreman.

At the Jackson Street shops of the Great Northern railroad at St. Paul, Minn., a lead reclaiming furnace has been constructed and has been in successful operation for some time. Prior to the time the furnace was constructed, battery sediment (as mud) which accumulated in the settling tank underneath the battery washing bench had to be sifted and cleaned and put into barrels before it could be sold and the amount received for this material did not pay for the labor required to handle it; moreover, scrap positive groups were sold for thirty dollars per ton. The figures here given will clearly show the amount of saving in reclaiming 1,800 lb. of pure lead when a test was made to determine the efficiency of the furnace.

Material	Weight	Scrap Selling Price
Sediment or mud	1,870 lb.	$8.25
Scrap positive group	830 "	24.90
Lime (Crushed lime rock)	...	.50
Coke (4-in. Screen)	1,300 "	6.82
Labor required	...	9.50
Total		$49.97
1,800 lb. of pig lead, selling @ 0.079c. per lb		$142.20
Net cost of material and labor		49.97
Net Profit		$92.23

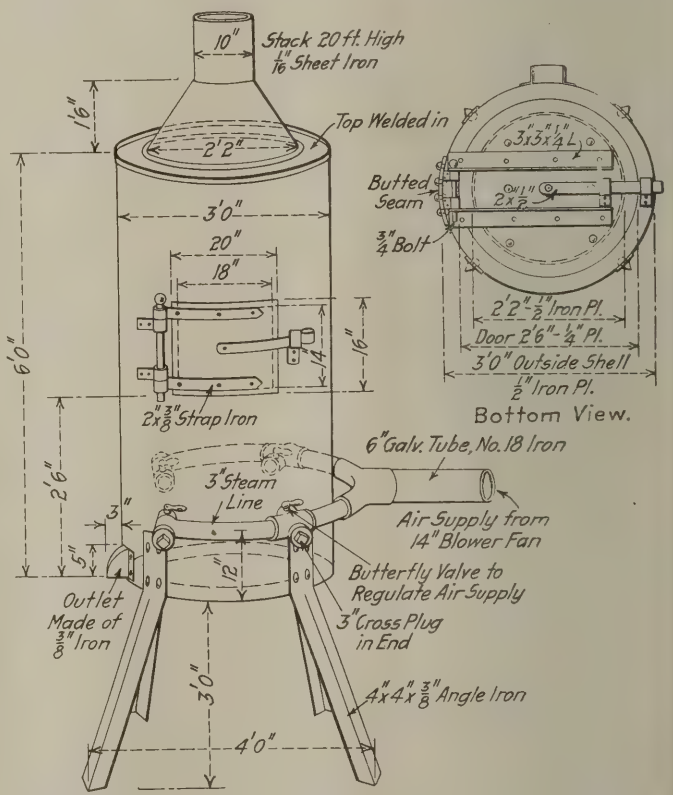
To construct the furnace an old boiler shell 36 in. in diameter and 1 in. thick was secured and a section 6 ft. long was cut from it. A side door was cut out by an acetylene torch and the piece removed was riveted to a ¼-in. iron plate, large enough to lap over the opening. The door thus constructed was hinged and a latch applied, as shown in the large sketch. A bottom plate of ¼-in. thickness was then welded in and the center cut out until an opening 2 ft. 2 in. in diameter was secured. This left a circular ring 5 in. in width on which the firebrick lining rested. The bottom of the furnace, which was constructed of the section cut out, was hinged as shown in the small sketch. This was done so that the bottom could drop down to facilitate cleaning and repairing of the brick work in the furnace.

The top plate was welded in and cut out in the same manner as the bottom and a cone was made with a flange and tapered to take a 10-in. stack which was riveted to the cone by ¼-in. rivets.

A hole was then cut into the side of the furnace one inch from the bottom, making an opening 5 in. square and a funnel welded around this opening to allow the pure lead and slag to run out.

Legs were made of 4 in. by 4 in. by ⅜ in. angle iron flattened 10 in. at the top, shaped to the side of the furnace and riveted into place with four ¾-in. rivets. The legs were made sufficiently long so that when the bottom door was opened it would swing free of the floor and not interfere with cleaning the furnace.

Four openings were made in the side of the furnace and 3-in. malleable iron T-pipe fittings were put in the front side. Two cross fittings were welded on also. Gate valves were applied to these fittings to regulate the



Sketches Showing Front Elevation and Bottom Door of Reclaiming Furnace

air supply which was derived from a 14-in. blower fan. Four peep glasses were placed in outside holes so that the fire could be watched.

The inside of the furnace was lined with firebrick which was stood on end and was kept one inch away from the iron shell of the furnace, the intervening space being filled with fire clay.

To place the furnace in operation the bottom door is closed and the sand is put in the furnace upon which

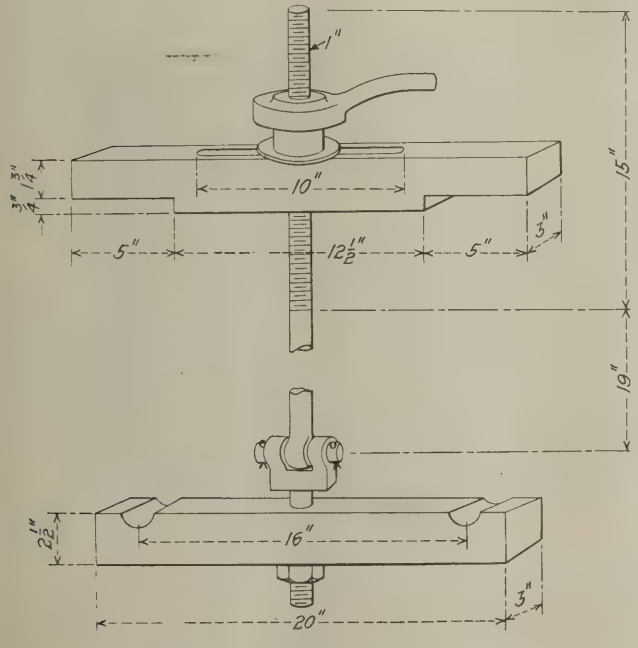
bricks are laid so as to lap over each other and taper toward the outlet hole.

The best results are obtained by using coke passed through a 4-in. screen. Allow the furnace to come to a good heat, put the sediment and plate into it on top of the coke and in a short time lead and slag will run out of the outlet. Keep adding sediment and plate to keep the lead running, adding a small amount of coke to keep the fire at the same height, which is about 6 in. above the blast holes. It will be found that the slag will tend to clog the furnace, but this can be overcome by adding a small amount of lime as crushed lime rock. Slag and lead can be run in the same catch pot as the slag will float and can be easily removed. The lead is taken from the catch pot with a ladle and put into lead ingot moulds weighing 100 lb. each. Twenty tons of lead have been reclaimed by this process since the furnace was installed.

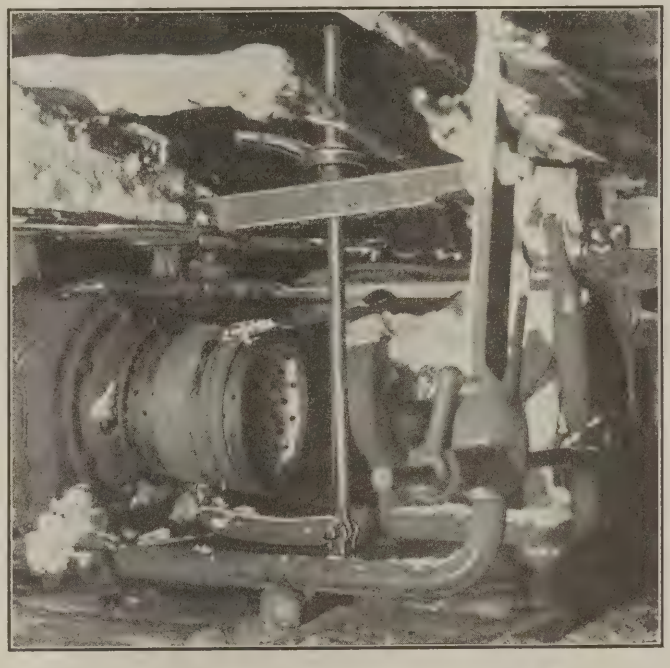
A Handy Toggle Jack for Raising Truck Hung Generator Supports

By William McKillen, Electrical Inspector, New York Central, Chicago, Ill.

When repair work has to be done on single point suspended car lighting generators or their supports it is often necessary to raise the U-frame or generator hangings. Anyone who has had to do such work knows how difficult the task of raising the supporting frame becomes when using screw jacks, bars or any other contrivance from the ground. This is especially true when the working space between the frame and the ground is limited, which is often the case during the winter, because of the frozen ground and the accumulation of ice and snow. At such a time the slippery condition of the snow or ice makes it almost inadvisable to attempt to use bars or screw jacks for such work. Because of these conditions we have devised a means, whereby the supporting frame of a single point suspended car lighting generator can be raised without depending upon the ground or anything else below the frame as a support for the raising apparatus. The device, which may be termed a toggle or lifting jack, consists of eight parts as shown in the illustrations. The toggle is that portion of the device which fits under the two U supports for the generator. It consists of a piece of hardwood, notched at each end. Through it, at the center, is a special bolt provided with a jaw-shaped head into which the eye end of an iron rod is fastened by means of an iron pin and cotters. The iron rod, which is threaded for a considerable distance at its upper end, passes through a slot in another piece of hardwood which serves as the supporting member of the device and is designed to fit between the center sill of the car and the iron bracket from which the generator supports are hung. On the top surface of the upper hardwood piece is an iron washer which acts as a bearing plate for a special nut which is provided with a handle for turning when it is desired to lift the toggle member which in turn raises the generator supports. After the supports are raised it is an easy matter to remove the pins near the point of suspension and lower the U-bars so that it is possible to renew the bushings in the eyes of the U-bars or to make any other repairs which may be necessary when the supporting frame of the generator is raised. This device is easily applied and can be operated and handled by one man.



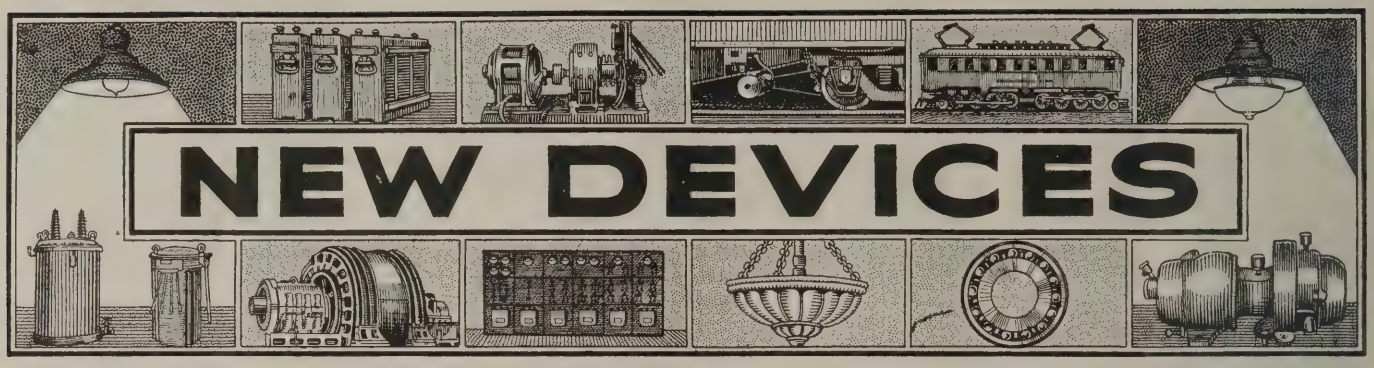
Details of Toggle Jack for U-Bars



Application of Toggle Jack To U-Bars

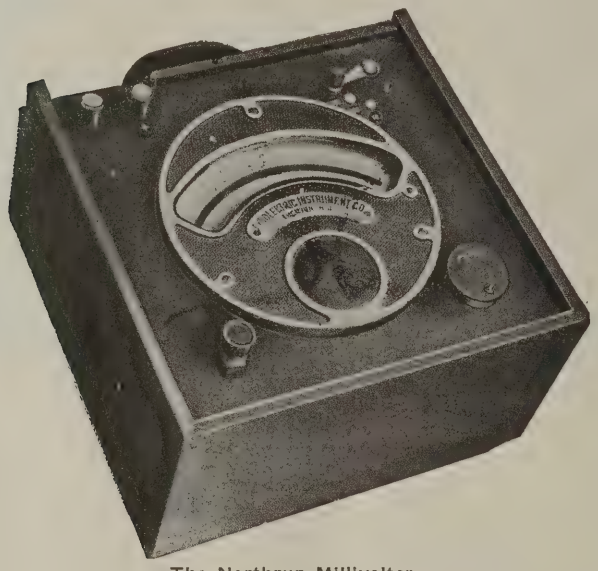
Oil Stains On Concrete Floors

Oil stains on concrete floors may be removed by using a mixture of 1 lb. of oxalic acid in three gallons of water with enough wheat flour added to make a paste that can be applied with a brush. Allow the application to remain on the oil stain for two days and then remove it with clean water and a scrubbing brush. If the oil stain is an old one it may be necessary to make a second application of the paste.



The Northrup Millivolter

The Pyrolectric Instrument Co., Trenton, N. J., have lately put out a portable deflection potentiometer which very closely conforms to the design of the Northrup Pyrovolter, and which is especially intended for measuring any voltage up to one volt without extracting any current from the source of e.m.f. being measured. This is accomplished by use of the Pyrovolter principle, which, briefly, is to balance an e.m.f. from a small dry cell con-



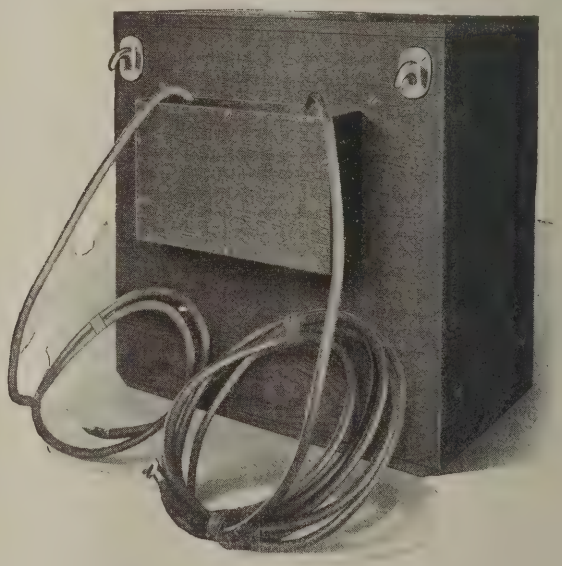
The Northrup Millivolter.

tained within the case of the instrument against the unknown e.m.f. by using a deflection meter as a balancing galvanometer. Connections are then instantly changed so that the meter is used as an indicating instrument to show the amount of voltage which has just been balanced as equal to the unknown voltage. Such a portable potentiometer offers an instrument of great utility for measuring a voltage drop in motors, for the calibration and checking of D. C. instruments, both ammeters and voltmeters, for the measuring of temperatures by the use of thermocouples, etc. With this instrument faults can readily be located in armatures by means of the "bar to bar test." This can be done without sending a large current through the armature as is necessary in the case of a large machine when using an ordinary millivoltmeter. Errors due to contact resistance are eliminated. Short circuited series field coils can be detected by measuring the drop across them when a current of known strength is flowing through the coils. The current flowing in a large cable can be very closely measured without the necessity of opening the circuit in any way. It is only necessary to measure the drop across a measured length of the cable and then compute the current flowing by Ohm's law. The resistance of the cable can easily be found in a copper wire table, which may be found in almost any electrical handbook.

The millivolter is made in one standard form of three ranges: 0-10, 0-100, 0-1000 mv.

An Alternating Current Welder

The Arcwell Corporation, of New York, has placed on the market a welding machine known as the Mephisto welder, which uses alternating current. The device weighs approximately 300 lb. and may be carried to the work by placing suitable rods under four hooks fastened near the top of the containing box, two of these hooks being shown in the photograph. It is



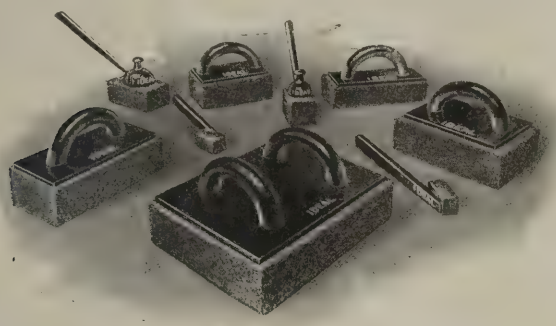
Primary Side of the Mephisto Welder

claimed that this welder can be operated on an alternating current circuit of any frequency and voltage with a power consumption of 3½ to 4 kw., and an efficiency of 90 to 95 per cent.

No regulating apparatus or external resistance is necessary as all regulation is inherent, the welder containing no moving parts. With current costing three cents per kw. hr., the manufacturer claims that the expense of operating the machine will be from 10½ to 12 cents per hour.

A New Commutator Resurfacer

The Ideal Commutator Dresser Company, Chicago, cago, has placed on the market a new device for resurfacing commutators and collector rings of motors and generators. The device, called the Ideal Commutator Resurfacer, is made of a hard abrasive substance similar to carborundum, furnished in three grades, namely: coarse, fine and extra fine, and in a wide variety of sizes to fit all kinds of commutators and collector ring conditions. Each tool is equipped with a convenient handle, the style and application of which varies, depending upon the size of tool and apparatus to which it is to be applied. In operating



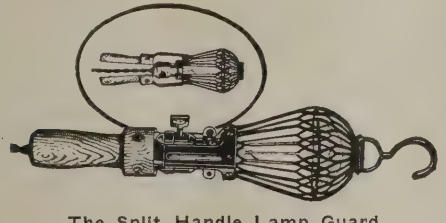
A Group of Resurfacers for Various Purposes

the device it is moved back and forth in the direction of the axis of rotation over the surface of the commutator. This action cuts down high mica ridges and high bars, smooths out the grooves and low spots while it does not collect copper dust, or wear smooth. The substance is non-metallic, thus eliminating the possibility of short circuiting. It is claimed that the resurfacing of commutators and collector rings can be done at full speed and loads without loss of time.

Split Handle Portable Lamp Guard

A new departure in portable lamp guards is shown in the illustration of the Flexco split handle which can be quickly attached to the Flexco expanded steel lamp guards made by the Flexible Steel Lacing Co., Chicago.

This portable successfully fills a demand for a substantial handle guard which does not need to be wired. The halves of the guard, including the handle itself, open wide from the hinge at the bottom of the guard and can



The Split Handle Lamp Guard

instantly be closed and locked around the socket at the end of any extension cord. The cord itself runs through grooves in the handle.

The new product will be found convenient in the garage, in the factory, in mills or in warehouse, because it permits light to be safely carried to dark corners, in stock bins, engine pits, etc. Fire danger is avoided and lamp users readily see the advantage and economy, as the modest cost of the guard is quickly repaid through prevention of lamp breakage.

Heavy Duty Safety Switches

The Palmer Electric & Manufacturing Company, Boston, Mass., has designed a heavy duty safety switch to meet the exacting requirements of service to which a switch and fuse may be subjected and at the same time fully protect the operator from shock even in the event of the apparatus being improperly connected, an important consideration in any accident preventative device where injury to one workman may be caused by the carelessness of another.

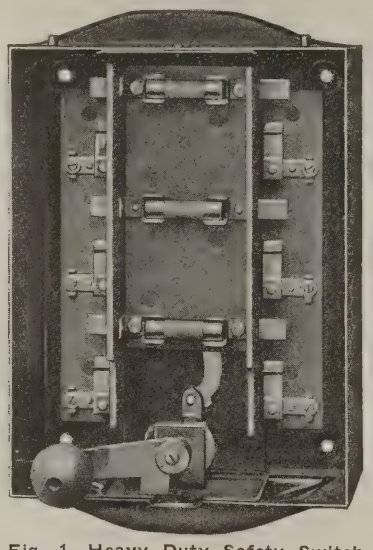


Fig. 1—Heavy Duty Safety Switch With Cover Removed

Fig. 1 illustrates the Palmer switch with the main cover removed to permit the connection of line and load wires; it will be noted that the switch is in an open position with the fuse disconnected from both line and load terminals and that the switch is moved to an open or closed position by a crank handle and toggle link which overset in both open and closed position thus locking the switch securely at its limits of motion.

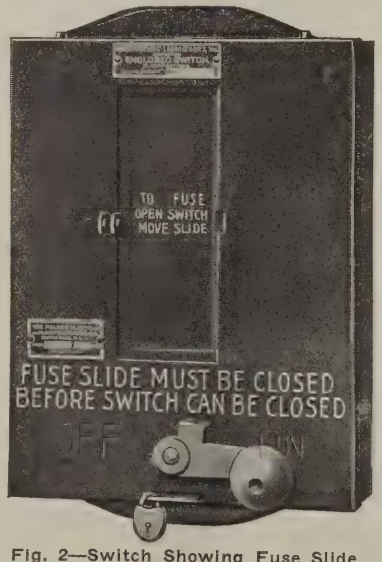


Fig. 2—Switch Showing Fuse Slide

A pair of barriers separate the fuse compartment from the terminal chambers, and when the main cover is in place the fuse slide gives access to the fuse chamber only. This slide is mounted on the main cover as illustrated in Fig. 2, and interlocks with the crank handle in such a way that the slide must be fully closed before the switch can be closed, and that the slide cannot be opened until the switch is fully opened.

Maximum switch life is secured by a design in which the operating end is the strongest part of the device, and the self-aligning knife blade contact can be depended upon to carry and break excess current values. The switch is quick break and the operator is never in doubt as to whether the switch is fully closed or open as it is impossible to leave it in any other position.

General News Section

Pennsylvania Railroad.—A contract has been given to E. H. Vare, Philadelphia, Pa., for building a new machine shop and new stalls in the roundhouse at Todd's Cut, Wilmington, Del.

The Spanish Government, in a royal decree, dated December 26, has authorized the railways of the country, all of which are privately owned, to advance their tariffs 15 per cent. The increase is allowed under a lengthy set of conditions, and is intended to cover increased costs of fuel, etc., but primarily increases in wages.

Telegraph wires and other wires on the Putnam division of the New York Central were put out of service, causing delay to a number of trains, on the night of January 14, by the theft of about 3,000 ft. of copper wire. The thieves worked between Dunwoodie, N. Y., and Ardsley, and, apparently, took several hours to do the job.

Railways in Siam have apparently suffered severely during the war, because of their inability to procure steel equipment necessary to maintain their efficiency. Advices are that they are in the market for iron framework, wheels and other parts. Eight Siamese students connected with the State Railways are about to visit the United States to study railway methods here.

Two Chilean Engineers are expected to arrive in this country in about three weeks to continue here their investigations concerning the electrification of the first section of the line of the Chilean State Railways between Valparaiso and Santiago. The government plans to submit the project to an international competition to secure the best system, following somewhat the same plan as was used in connection with the new shops at San Bernardo near Santiago.

The Pennsylvania Railroad, Western Lines.—Work is now being undertaken on a number of new buildings and other facilities incident thereto in connection with a large car repair plant in the east yards of Terre Haute, Ind. The following buildings are under construction or contemplated: Office building, women's locker room, men's locker room, paint shop, freight car repair shop, storeroom building, planing mill, extension to power house and material and scrap bins.

The Railways of India on March 31, 1914, had 170,444 freight cars. The number laid up for repairs at present is about 10,290, or about 6 per cent of which 1,860, or about 1 per cent of the total, were laid up for want of materials. The number is lower than in normal times, owing to the efforts the railways were making to keep every available freight car on the road. The number of cars sent overseas was 4,251; all of these except 56 were of metre or 2 feet over 6 in. gage.

The Great Scarcity of Coal in Italy has made it necessary to use wood and lignites for fuel in locomotives. The boilers and fire boxes of the locomotives have had to be changed to suit the new fuel, and employees re-educated to a considerable extent. The use of substitutes for coal as fuel has been urged on all manufacturers, and prizes have been offered for noteworthy economies. In addition to that, two companies, with an initial capital of $1,200,000 each, have been formed for the development of lignite or brown-coal mines in Italy. One will operate mines in northern, the other in southern Italy.

The National Railways of Mexico, according to a report from Monterey, are being rehabilitated under plans which are making a fair degree of progress. All bridges on the main lines are now repaired and in use, and many of the stations have been rebuilt in a permanent manner. The roadbed is reported in fair condition. The number of locomotives in service is about 500, of which 100 belong to industries along the line and are used in the freight service of their owners. About 250 more locomotives are awaiting repairs, delay having been incurred in getting the repair parts from the United States. To handle even the minimum volume of traffic about 1,000 locomotives ought to be constantly in use, and the question of acquiring some new ones is now under consideration.

The American Association of Engineers, which has a railroad committee studying the railroad wage problem as affecting civil, mechanical and electrical engineers employed by the railways, will set aside for the use of this committee one half of all receipts from new railroad members during the month of January. This money will be used to make a study of the wages paid to technical engineers in railway employ and to make representation of the results to the Board of Railroad Wages and Working Conditions, the regional railroad directors and others. The railroad committe is composed of W. H. Finley, president of the Chicago & North Western; E. H. Lee, president of the Chicago & Western Indiana, and W. W. K. Sparrow, corporate chief engineer of the Chicago, Milwaukee & St. Paul.

Car Lighting Men Meet

The members of the New York Car Lighting Association gathered at their regular meeting place on Tuesday evening, February 4. In spite of the bad weather a very creditable number were out to greet their new president, W. C. Kershaw.

In a brief address Mr. Kershaw requested the same hearty co-operation in carrying on the work of the club that has been given to the retiring president. The assurance of support the president received in answer to his request was particularly gratifying and showed that the New York club is a live organization and that they are deeply interested in their work. It is unfortunate that similar groups of car lighting men do not seem to

be able to create sufficient interest to duplicate the work of the New York club, but it is hoped that the successful activities of this association may be the means of stimulating men in other localities to organize themselves. There is no question but that an immense amount of good is derived from an open discussion of the everyday problems in car lighting work.

No particular subject had been arranged for this meeting, but the question of tools required in car lighting maintenance was brought up and a very interesting discussion followed. This discussion eventually led to the appointment of a committee by the president for the purpose of drafting a list of tools required by each car lighting electrician.

The next meeting of the association will be held on March 4, in the battery house of the Delaware, Lackawanna & Western railroad at Hoboken, N. J. At this time a demonstration of the Gould equipment will be given and a splendid opportunity will be presented to obtain information regarding this apparatus. For the benefit of those not familiar with the location of the battery house it was decided that the members should meet in the D. L. & W. train shed at the foot of track No. 14 at eight p. m. Unless you are particularly anxious to miss something good, you had better be on hand.

New Railroad Y. M. C. A. Buildings

The two new Railroad Y. M. C. A. buildings were opened during January. One of these was at Maybrook, N. Y., on the New York, New Haven & Hartford; the other one was at Coxton, Pa., on the Lehigh Valley, this being the first Railroad Y. M. C. A. building on that line. Special exercises were also held at Elsdon, Illinois, on the Grand Trunk, in connection with the completion of the second addition to that building, made necessary by the constantly increasing growth of the association.

Electrical Engineers to Hold Convention

The seventh annual midwinter convention of the American Institute of Electrical Engineers will be held February 19-21, 1919, in the Engineering Societies Building 33 West Thirty-Ninth Street, New York. The convention will open Wednesday afternoon in joint session with the American Institute of Mining Engineers, at which a symposium on "Electric Welding," will be presented. In the evening a lecture will be given by Dr. John A. Brashear, the subject of which is "An Evening With The New Astronomy." This will be followed by an exhibition of technical moving pictures as adopted by the United States War Department for the instruction of the army in the operation of various mechanical devices. These pictures will be accompanied by brief explanatory remarks. Ladies will be welcome at this session.

The first technical session will be held in assembly room No. 1 at 10:30 a. m. on Thursday, at which time papers will be presented by C. P. Steinmetz and H. S. Osborne. Thursday afternoon will be given over to a visit to the Brooklyn Navy Yard. On Thursday evening at seven o'clock a dinner-dance will be held at the Hotel Astor, Broadway and Forty-fourth street, New York. The purpose of the dinner-dance is to provide a pleasant social function for the entertainment of the members and their guests in attendance at the convention.

Two technical sessions will be held on Friday, one in the morning beginning at 10:30 and the other in the afternoon at 2:30. At these sessions papers prepared by G. B. Shanklin, J. J. Matson, F. Dubsky, L. F. Blume, A. J. Boyajian, E. B. Craft, E. H. Colpitts, John R. Carson, and W. W. Crawford, will be presented.

Plenty of Rolling-Stock in Germany

The London Times' special correspondent at Berne telegraphed to his paper recently that in view of the German "shrieks" about shortage of rolling-stock it is interesting to learn from a leading German railway magazine of December 4 that, in spite of the congestion of the railways with military trains, the transport of food and coal is being carried on without difficulty.

Five Business Cars for Sale by Interstate Commission

The Interstate Commerce Commission has for sale five business cars with their contents. These cars were purchased from the Pullman Company in 1914 and 1915, and were standard Pullman cars of wooden construction, overhauled and refitted to serve the purpose of office or business cars for use of field parties in the Bureau of Valuation. Sealed proposals for the purchase of these cars will be received at the office of the chief clerk and purchasing agent of the Interstate Commerce Commission, Washington, and there opened at 10 a. m. on Tuesday, February 25, 1919.

Troops Live in Box Cars

When operating through the thinly populated forest and tundra region along the railway leading from Archangel to Vologda, the American troops fighting the Bolsheviki on the north Russian front are living, when free from trench and blockhouse duty, in tiny Russian freight cars, says the Associated Press. In this they are imitating the Russian soldiers, who, since the revolution, have commandeered freight cars wherever they found them and remodelled them for dwellings.

When the box cars are fitted up with stoves they are known as "topluchkas." They are not particularly warm in zero weather, but a welcome change from the cold trenches in the snow.

Maximum Anthracite Prices and Other Restrictions Suspended

Maximum prices on anthracite coal, together with all other coal and coke regulations except three, have been suspended by the Fuel Administration. The only restrictions not suspended, as to coke and all coal, are: Those requiring that contracts be made subject to maximum prices if reinstated, subject to cancellation by the Fuel Administration and subject to requisition or diversion of coal by the Fuel Administration. Those prohibiting reconsignments of coal. Those requiring shipments of coal to tidewater to go through the Tidewater Coal Exchange. The order includes the suspension of price and zone regulations on coke and bituminous coal which went into effect February 1. The administration's control of the oil industry already has been mostly suspended, so that the Fuel Administration's controls are now relaxed to the present limit of safety.

PERSONAL

W. N. Alexander, electrical inspector on the Chicago Great Western, has been appointed assistant chief electrician of the same road with headquarters at Oelwein, Iowa.

Alfred G. Oehler, who received a commission as Ensign in the United States Naval Reserve, Submarine service, in August, 1918, has returned to the Simmons-Boardman Publishing Company as associate editor of the Railway Age. Before entering the service of the United States Navy Mr. Oehler was managing editor of the *Railway Electrical Engineer.*

OBITUARY

W. H. Higgins, signal engineer of the Central of New Jersey since 1901, with headquarters at Elizabeth, N. J., died on January 15 at his home in Jersey City, N. J., at the age of 61. Mr. Higgins began railway work when about 17 years old with the Pennsylvania Railroad in the telegraph department. He subsequently had charge of the electric lighting and interlocking on that road at Jersey City. In 1901 he went to the Central of New Jersey as signal engineer, which position he held at the time of his death. Mr. Higgins superintended the construction of block signals on practically the whole of the important passenger lines of the Central of New Jersey.

TRADE PUBLICATIONS

The National X-Ray Reflector Company, Chicago, has recently issued a 16-page pamphlet entitled "X-Ray Indirect Lighting for Offices." A number of interesting photographs are shown which illustrate very clearly the value of indirect lighting for office use.

The Esterline Company, Indianapolis, Ind., in an 8-page envelope folder illustrates and describes the "MS" power factor recording instruments which it manufactures. Photographs of the internal mechanism are shown and detailed information of the various parts is given.

Trumbull Cheer for January says: "There is no doubt in the world but that all will come out well and that the electrical business will be better than ever, when things are a little more settled, and in the meantime prices cannot go down nor can the basic wage be reduced without great misfortune."

The Arcwell Corporation, New York, is distributing a four-page illustrated folder entitled "The Mephisto Welder." The important features of this welder, which is an alternating current device, are set forth in this folder together with a partial list of companies who are using the machine.

The Welding Materials Company, Inc., New York, in its booklet 1915-A, describes and illustrates the various arc welding equipment which it is marketing. A portion of the pamphlet is devoted to a description of the kinds of electrode to use for certain classes of work. The welding machine sold by the company is of the variable voltage type.

The Hart & Hegeman Manufacturing Company, Hartford, Conn., has just issued a new catalogue in which are listed the "H & H" switches and accessories, together with "Paiste" wiring materials. The new book, which is known as catalogue "P," is 8½ by 10 in. in size and contains 183 pages, which are devoted to the illustration and descriptions of the extensive line of fittings manufactured by the company.

Trumbull Electric Manufacturing Company, Plainville, Conn., in its January, 1919, bulletin No. 2, entitled "Safety Service" Externally Operated Switches, illustrates and describes a very complete line of switches which may be operated from the exterior of the containing box without exposure to any of the current carrying parts. Full details together with prices are given for each of the numerous types manufactured by the company.

Rownson, Drew & Clydesdale, Inc., New York, is distributing the January number of its house organ, "The Reporter." The pamphlet includes a number of brief sketches of the lives of the men who were the founders of the company. Rownson, Drew & Clydesdale, Inc., are manufacturers of iron and steel products and at the present time are interested in marketing the Donald portable elevator, a machine designed for the purpose of loading and unloading ships in the shortest possible time.

The Crouse-Hinds Company, Syracuse, N. Y., has signed several new condulets for use in electric headlight wiring on steam locomotives, which are listed and illustrated in bulletin No. 1000-1. A plan view and side elevation of a locomotive and tender wired with conduit and condulets, and sectional views of the installation are shown in the catalogue, with a list of the materials required. These drawings are complete insofar as is possible to make them and they should be of value to anyone charged with the work of installing electric headlights.

The V. V. Fittings Company, Philadelphia, Pa., has recently issued its catalogue No. 21, in which are listed all of the many products of this company. The book which is 8½ by 11 inches, contains 128 pages. The fittings are well illustrated and their descriptions are very complete. A number of useful tables are included in the latter portion of the book, one of which, shown on page 111, is unique, inasmuch as it gives the size of motor equipment required for metal working machinery—something not often included in a catalogue of this kind.

The Cutler-Hammer Mfg. Co., of Milwaukee, is distributing a novel two-page two-color envelope folder which illustrates and enumerates the advantages of the C-H 91-16 Starting Switch for A. C. Squirrel Cage Motors. This enclosed motor starting switch which has been previously illustrated and described in the pages of *Railway Electrical Engineer,* has a steel case which entirely encloses the mechanism and fuses with only the operating handle extending through and it is so constructed that the operator cannot come in contact with any live parts. The switch is automatically locked in the open position when the fuses are exposed and the fuses are made dead. These starting switches may be operated by an unskilled operator, either man or woman, and safety stop buttons may be placed at various locations so that in case of a dangerous machine the operator or others may push one of these buttons and bring the machine to rest, should an accident occur. The folder gives all necessary dimensions for installation.

Railway Electrical Engineer

Volume 10 March, 1919 Number 3

THE WAGE QUESTION AGAIN

The adjournment of the sixty-fifth Congress without the passing of the $750,000,000 revolving fund appropriation, so much desired by the Railroad Administration, is regarded by many as a decidedly critical state of affairs in the government operation of railroads. That the money is sorely needed cannot be doubted; in fact, had it been granted it is very improbable that it would have been sufficient to meet all the demands that would have been made upon it. The truth is that the operation of the roads under government management cannot be looked upon as a wonderful financial success, no matter how the facts are presented, and one of the biggest reasons why such a poor showing has been made can be directly attributed to the phenomenal increases in wages under government control.

From the very beginning of government operation Mr. McAdoo handled the question of wages in a manner that was most alluring to the rank and file of railroad employees. The necessity for increasing the wages was perfectly clear, otherwise railroad men would have gone over by the thousands to the more attractive war industries. Ever since those early days special orders and supplements have been issued by the Railroad Administration in a vain endeavor to produce satisfaction and contentment by readjustments. Have these wage adjustments solved the problem? No—all they have succeeded in doing is to shift the discontent from one group of men to another. There are instances galore where foremen receive less than men under them, and everyone knows that such a state of affairs is not conductive to efficient railroading. In general, however, there is not a railroad employee who has not benefited very much financially from government control. Most of them are drawing more money than they had ever expected to, but they are not contented. The trouble does not lie in the lack of actual increase over the amount received prior to government operation, but rather in the relative difference in hourly wage between one group of the men and another. Adjustment has followed adjustment, and successively the hourly rating of one group after another has been boosted and boosted until the railroads have become a most desirable place to work.

There is no question but that formerly many railroad employees were not paid what they deserved, but it is equally true that today there are thousands who are receiving much more than they actually earn. To make matters worse the Railroad Administration has encouraged the formation of various labor unions which have played havoc with discipline in many instances.

Under these conditions it is not strange that the Brotherhood of Railroad Trainmen last month endeavored to have adopted a plan whereby government control might be perpetuated, nor is it strange that with wage increases of $583,000,000 during 1918 that the Railroad Administration shows a loss of $200,000,000 in operating income.

That the present state of affairs cannot persist is evident to all who will give the subject sober thought. Conditions should not exist whereby workmen are able to draw more money than the foremen, who are obliged to shoulder the responsibilities. Railroad men should receive wages in proportion to their respective qualifications, but there is absolutely no sane reason why they should receive wages that are altogether incompatible with the service rendered.

THE RIGHT MAN FOR THE JOB

In the February issue of the *Railway Electrical Engineer* an interesting table was published which gave some very definite information with reference to the position occupied by the heads of the electrical department on a number of railroads. While the list is by no means complete, it is not too much to say that it is quite typical of the actual conditions which prevail on most of the systems. Lack of uniformity in the several electrical departments is immediately apparent, but the thing that stands out prominently and which has particular significance is the fact that on the great majority of roads the electrical engineer reports to the head of the mechanical department.

From the time the first steam railroad began operation up to the present day all of the work in connection with railroad cars and locomotives has been classified as mechanical. That this has been the case excites no particular comment for the reason that until within the last few years the classification has been perfectly logical and just. The time is rapidly approaching, in fact it has already arrived on some roads, when a new classification must be made. The extensive introduction of electricity has so greatly changed operating conditions on some roads that there exists a most urgent need for an electrical department, clothed with some authority and not a subsidiary of the mechanical department.

The number of problems which are strictly within

the province of the electrical engineer is increasing every year. The railroads already have spent large sums of money for electrical equipment and future expenditures along this line will amount to hundreds of thousands of dollars. If this money is to be used intelligently, the logical man to supervise the handling of it is the electrical engineer, who is familiar with electrical equipment.

Electrical men should make every effort to build up organizations that have real authority—organizations that are not dependent weaklings but, on the contrary, will be looked up to and respected and whose decisions pertaining to electrical matters will be accepted without equivocation. To accomplish this something more is required than the mere wishing for it, for it must not be thought for a moment that the mechanical man who has enjoyed a position of superior rank for years is going to lend his assistance to the formation of any organization which will deprive him of his previous authority. It is nevertheless a fact that there is a distinct difference between mechanical and electrical matters and in most cases the line of demarcation is clearly defined. There is no good reason why the electrical engineers should not rank on a par with the mechanical engineers if both men are of the same caliber, but there is every reason why equality should not exist if the electrical man is manifestly inferior. Electrical departments will receive the recognition that they desire when they are headed by men who are capable of doing big things in a big way. Such men compel respect by their knowledge. Their opinions will be sought after, their services will be in demand and the department which they represent is certain to be accorded its proper place in railroad organization.

WHY NOT UNIFORM CAR WIRING

The application of the National Electrical code to the installation of axle generator equipment may seem, at first thought, to be somewhat far-fetched. The underwriters' rules were adopted first in 1897 for the purpose of establishing a uniform and safe practice in the wiring of buildings and the housing of electrical equipment. The original object of the rules has remained the same through the twenty-two years of their existence, but the passing of time has seen many important changes in the original code. Experience of years has proved unquestionably the wisdom of the adoption of these regulations, not only as a preventative of fires of electrical origin, but for the benefit derived from a uniform system of electrical wiring performed in a careful and thorough manner. It is this latter function of the code which has its application to car lighting work, rather than the consideration of the fire hazard. Strict adherence to the underwriters' rules, as far as they are applicable to car wiring, could well be followed with decided profit. The gradual elimination of undesirable methods which have proved to be a source of trouble and the substitution of better ways in their place has resulted in specifications that are well nigh perfect.

While it is a fact that in general the large majority of these rules find no direct application in car wiring it is equally true that some of them do, and if such of them as do apply were faithfully followed there is little doubt that the result would be clearly reflected in a desirable uniformity of practice and a decided reduction in the cost of maintenance.

EDUCATION AND LABOR

One of the most astounding facts that came to light during the war was the condition revealed by the draft, when out of an army of 2,000,000 men it was discovered that 200,000 could not read their orders or understand them when delivered, nor could they read letters that were sent to them from home. That such a condition of affairs should exist in the United States with its excellent system of public schools is most remarkable and proves decidedly that the problem of education is only partially solved. It is estimated that there are eight and one-half million persons in the United States over ten years of age who cannot read a newspaper, billboard, car card, sign, booklet or letters in the English language. More than half of them cannot read anything in any language.

When we gaze upon the horrible nightmare that is going on today in Russia, the fact that stands pre-eminently above all others is that the mass of the people are hopelessly ignorant. Beyond all doubt it is this very fact that makes possible in these days such a chaotic condition. Even though so many in our own land lack the rudimentary elements of education, the duplication in America of anything corresponding to the Russian debacle is absolutely unthinkable. The rank weed of Bolshevism has been transplanted to the United States but it cannot flourish here. Even in localities where its growth might be expected it withers and dies, and the chief factor in its destruction is the general enlightenment of labor.

Our problem in the matter of education is to make it possible for every person living in this country to read and understand our language. If even this much can be accomplished a big step will have been taken toward the ultimate betterment of our illiterate classes. When once these people are able to read the printed word, the wide open road of self-education will present most alluring aspects to them.

The railroads of this country are among the greatest employers of uneducated labor and as such it becomes their duty in a certain sense to provide some means for the educational uplift for these workers. Among the roads that have recognized this responsibility and have taken measures to assist their employees are the Union Pacific, the Illinois Central, the Central of Georgia and the Pennsylvania. While it is quite true that the corresponding courses which these roads have made available to their men require an ability to read either English or Italian print, there is no reason why educational activities should make this a starting point. The thing of first importance is to teach the men to read and write. It may not be as easy a matter to begin the work with these simple fundamentals, for it means personal instruction, but it is the logical place to start. Once this is accomplished the men will be able to avail themselves of the more advanced courses and the foundation of a structure will be laid that is certain to result beneficially to both employer and employee.

A General Discussion on Joining Metals

An Introductory Article of a Series on Electric Welding. History Leading up to the Subject

By E. Wanamaker and H. R. Pennington*

THERE are several methods of joining metals other than by means of mechanical fastenings, such as bolts, clamps, rivets, hinges, etc. The first form of jointure known to man, other than the above-mentioned means, was fire or forge welding performed by a smith; the operation consisting essentially of heating the parts to be welded to the proper temperature, then fusing them together by applying pressure in the form of hammer and anvil. Inasmuch as pressure welding was limited in its application, man endeavored to find some other way to join metals, or to make additions of metal to other metal without the use of pressure. In this endeavor he was eventually successful and welding without pressure came to be known as autogenous welding. We, therefore, have two general forms of welding; one requiring external application of pressure to complete the weld; and one in which the weld is completed without the external application of pressure. In the first form fusion is secured by using a comparatively low heat and high pressure. In the second form fusion is secured by comparatively high temperature with no pressure necessary. It will be seen that in view of the fact that welding requires actual fusion of the metals joined or added that the process differs inherently from those methods of joining metals known as brazing or soldering, in which cold surfaces are united by the interposition of a fused metallic cementing material.

Pressure Welding

The conditions for successful smith or forge welding, which is a form of pressure welding, may be summed up as clean metallic surfaces in contact, with a suitable temperature and rapid closing of the joints. All the variations in the forms of welds are due either to differences in shapes of material or to the different practices of different craftsmen. The typical weld is the scarf; the joint is made diagonally to give a long contact at the point of union. Abutting faces are made slightly convex. The object is to allow any scale or dirt to be forced out which if allowed to become embedded in the joint would impair its union. It is very important to have the proper temperature or else the metal will become badly oxidized (burnt) and will not adhere. This is especially true in the case of steel welding.

Resistance Welding

Resistance welding is another form of pressure welding in which an electric current is made use of to produce the welding heat. There are two general forms of resistance welding; namely, *butt* and *spot*. The name in each case being thoroughly indicative of the service for which each form is particularly adapted. Butt welding is accomplished by having the surfaces, or parts of the metal to be united, fitted approximately to each other. Clamps of suitable design, generally made of copper, are then attached in as close proximity to the weld as is practicable in such a manner as to permit the desired amount of current to pass through the parts to be joined or welded. The resistance offered to the passage of the current at the point of contact produces the welding heat; whereupon sufficient pressure is applied to effect the union. Spot welding also utilizes the heat generated by the resistance offered to the passage of an electric current, similar to butt welding, except that the heat is largely generated at the points of contact between the respective electrodes and the plates or parts to be joined or welded. Seam welding utilizes heat generated in a manner very similar to spot welding; in fact, it is an extension of spot welding. Spot welding is equivalent in form to flush riveting; likewise seam welding is equivalent in form to flush riveting, except for the fact that the weld is continuous like a row of adjacent rivets, were such a thing possible; in other words, a seam weld is a non-interrupted continuous succession of spot welds.

All forms of resistance welding require primarily a heavy current at a low potential which practically necessitates the use of alternating current. The welding equipment, therefore, generally consists of a step-down transformer with regulating device, clamps or electrodes for making the electrical connections to the work, together with suitable mechanical parts and devices for supporting the electrodes, supplying pressure to the weld and supporting the parts to be welded. In general, it may be said that the resistance form of welding is best adapted to standardized operations, especially so in the manufacturing field where the work can be passed through the machine. While it might seem that the application of this form of welding is somewhat limited there is, nevertheless, a vast field for it that has not yet been invaded.

Thermit Welding

In the year 1894 it was found that the ignition of finely powdered aluminum, mixed with metallic oxides, produced an exceedingly high temperature because of the rapid oxidation of the aluminum. These facts were turned to practical account by Dr. H. Goldschmidt, who welded two iron bars by means of molten iron produced by the process to which the name of "thermit" is now commonly applied. This process has been wonderfully successful and has been extensively used especially for welding members of large cross sections and for emergency repairs on certain classes of work. Thermit welding is sometimes called a casting process, since it requires a mold around the parts to be joined.

Gas Welding

The oxy-hydrogen blowpipe was first used about the year 1820 chiefly for producing limelight. It was also used in some important industrial applications; one of which was the fusion of platinum. In the latter part of the nineteenth century this process came into extensive use for lead burning, or welding. About the same time

*E. Wanamaker, electrical engineer of Rock Island Lines. H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines.
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it was discovered that by using oxy-acetylene a much higher flame temperature could be secured, which together with improved regulation of heat control, led to the extremely rapid use and extension of the oxy-acetylene torch to the welding and cutting of iron and steel and other metals to a lesser degree. While other gases have been used somewhat in place of acetylene the oxy-acetylene flame is by far the most widely used. Today the oxy-acetylene welding and cutting process is used in practically all of the metal using industries.

Electric Arc Welding

Electric arc welding is commercially the most recent and newest process of any form of welding. Benardos and Slavianoff are generally credited with the discovery of the possibilities of the carbon arc and metallic arc, respectively, for the welding of metals. The carbon arc process was the first one to be used for welding of metals, and was first used, on a small scale, thirty years ago. This form of arc welding is sometimes called the Benardos process. Not long after the carbon arc process was demonstrated by Benardos, Slavianoff demonstrated the possibilities of the metallic arc process, but it was not until comparatively recent years that either was used to any appreciable commercial extent.

After the first discovery of the more or less vague possibilities of electric arc welding the progress in the development of the art was extremely slow, due to the fact that it was only with great difficulty that the work of development could be carried on. There were several reasons for the existence of such a condition, most important of which was the fact that the men who first conceived and worked to develop and improve the welding art were apparently versed only in one branch or phase of that science. It must be borne in mind that to develop this art it was necessary to make searching and extensive investigations into the phenomena existing in the arc, both carbon and metallic, when using it for the fusion of metals. No matter how well versed a man may be in electrical science it does not necessarily follow that he would understand the behavior of an electric arc when used for welding metals. On the other hand, although a man may be well trained in metallurgy it does not necessarily follow under ordinary conditions that he would understand the behavior of the metals when under the actions of the electric welding arc. In other words, the electrical men did not understand, nor were they thoroughly acquainted with the peculiarities manifested by the electric arc when used in conjunction with molten metal during the welding process. And the metallurgical men were not conversant with the behavior of metals under the action of the arc stream with its attendant high temperature variations. In view of these existing conditions it was necessary that much time be spent in research work by both electrical and metallurgical men. Indeed, it was not until the electrical phenomena and metallurgical phenomena were coordinated that a real beginning was made in the development of the art of arc welding. And not until then did the metal using industries begin to see the possibilities of its use and to lend their financial assistance to its development.

The Electric Arc

If two carbons which are connected to a sufficiently powerful electric source be brought together and then slowly separated the current will not cease to flow, provided they are not too widely separated. An arc will be formed and the current will continue to flow, since the vapor formed between the two carbons serves as a conductor for the passage of the current across the intervening space. The temperature of the positive electrode of a carbon arc has been estimated at about 7,500 degrees F. If an arc be formed between two metallic electrodes the temperature will be somewhat lower. The temperature of any arc will be limited to the vaporization of the materials forming the electrodes.

In electric welding the heat is communicated to the metal by an electric arc. In one method the arc is deflected from the space between the carbon electrodes by a magnetic field. In this case the metal takes no part in the conduction of the current; the heat is communicated by the gases of the arc, and to a small extent by the radiation from the hot carbon electrodes between which the arc is formed. This particular method was inherently not a commercial success, as is evidenced by the mechanical impracticability of applying the arc to the work. Also, minute particles of carbon in the arc stream produced by the consumption of the electrodes were deposited in the weld; thereby leaving the finished weld exceedingly hard.

The form of carbon arc welding, generally referred to, is one in which the work, or part on which metal is to be added, forms the positive pole of a direct current circuit, and an arc is drawn between this and a carbon rod to which a handle is attached for manipulating. At the point of arc contact on the work the metal becomes molten. The metal, which is necessary to add to the weld, is supplied by melting a filler rod in the arc; the minute globules of molten metal commingling and fusing with the molten metal of the parts to be welded. In this method the bad effects of deposited carbon are largely eliminated by making the work positive, in which case the current flows from the metal to the carbon instead of from the carbon to the metal, as was the original and former practice. A constant potential source of current supply, together with a choking resistance in series with the heating arc so arranged as to permit an adjustment of current strength, has long been used and is yet, to a considerable extent. Sufficient potential is always required (approximately 70 volts) to steadily maintain an arc of proper length. The current required will range from 50 amperes to 600 amperes, and even higher in some instances, depending upon the character of the work in hand.

The carbon arc process has been limited in its scope of application by its practical confinement to down-hand welding; to the tendency to oxidation resulting in brittleness; to large area heated, resulting in the bad effects of excessive expansion and contraction, loss of energy or heat, radiated by large arc area and conduction by the metal being welded; and the necessity of heavy currents with the cumbersome equipment required.

During the past twelve months much has been contributed to the electric welding art. Most of the development has been along the lines of metallic arc welding, consisting of improvements in equipments, electrodes and weld protection, which has in turn led to a more intelligent application of the process, and the resultant greater extension of its use.

Metallic arc welding consists of drawing an arc be-

tween the part to be welded and a metallic electrode. The electrode is in the form of a wire, or small rod. It may or may not be of similar composition as the metal which is to be welded. The arc is established by striking the wire electrode to be fused to the work with a dragging touch and withdrawing it a slight distance, approximately ⅛ inch, forming what is known as the metallic arc. This form of arc welding differs from the carbon arc in the fact that the heat of the arc (formed between the end of the electrode, or wire, and the work) melts the electrode and the highly molten metal in minute globules is projected across, or through, the arc, commingling and fusing with the molten metal (so made by the arc's contact with the part to be welded) which forms the opposite electrode. Due to the fact that it is possible to project metal horizontally and vertically upward, it is possible to do welding on a wall, or overhead, with this form of arc welding, something which is not possible with the carbon arc. It is this fact that makes the metallic arc welding process to all intents and purposes universally work-wise, and gives it an extremely wide field of application. The power consumed for metallic arc welding depends upon the character and mass of the metals forming the electrodes. As a rule, the average range of potential and current is 15 to 35 volts and 50 to 200 amperes, respectively, measured at the arc.

After many years of research it has been conclusively demonstrated that the metallic arc welding process demands a certain close co-ordination of the equipment and the electrode, if the best results are to be obtaind. Efficient electric welding equipments are on the market today, and great strides have been made in the perfection of electrodes for various services.

It is the intention of the authors to cover the requirements, design, and installation of electric welding equipments, together with a complete treatise to date on the subject of electric arc welding in the several articles which are to follow, carefully treating each phase of the subject in turn, and concluding with recommended practice of detailed application to the various actual operations, which have come under our personal observation.

THE TELEGRAPH SYSTEM OF CHINA is operated by the government and is generally conducted in connection with the telephone system. There is no likelihood of any lines being built by private companies.

LOCOMOTIVE ELECTRIC HEADLIGHT WIRING

An interesting and well-arranged method of wiring locomotives for electric headlights has been developed by the Pennsylvania Lines West in connection with the electric headlight program on that road. Every effort has been made to provide a system which is free from the possibility of short-circuits and which will occasion the least amount of trouble when a locomotive is being stripped for repairs. The generator is located just ahead of the cab, a steam connection being made from the blower line through the cab with a union joint just outside of the cab.

Three classes of service, namely, road, shuttle and yard service, are provided for. Fig. 1 shows the general arrangement of the wiring and fixtures for locomotives in shuttle and yard service. These are similar to the arrangement for locomotives in road service with the exception of the wiring to the tender, which is eliminated. Fig. 2 gives the wiring diagrams for the three classes of service. They are fundamentally the same. The diagram for locomotives in shuttle service is different from that of the diagram for locomotives in road service in that it provides for the headlight and classification lamps for the tender. The diagram for yard service is different from the diagram for shuttle service in that no dimmer resistance is required. The circuits are controlled by single-pole push-button switches which are located on the side of the cab within easy reach of the engineer. For road service three switches are provided. The top one is the main operating switch energizing the entire system. The middle one governs the circuit to the reading lamp, which is located on the side of the cab back of the engineer. The lower switch throws the dimmer resistance in or out as required. This provides a very convenient arrangement and eliminates any possibility of the headlight being thrown out of service by mistake when it is desired to cut in the dimmer resistance. It will be noted that a key socket is provided at the classification lamps. This is done for the purpose of insuring proper inspection of the lamps when it is necessary to turn the lights on or off. The deck and gage light, together with the headlight and number light are on the main circuit and are always lit whenever the circuit is closed. They are wired in parallel so that the failure of one light will not break the main circuit.

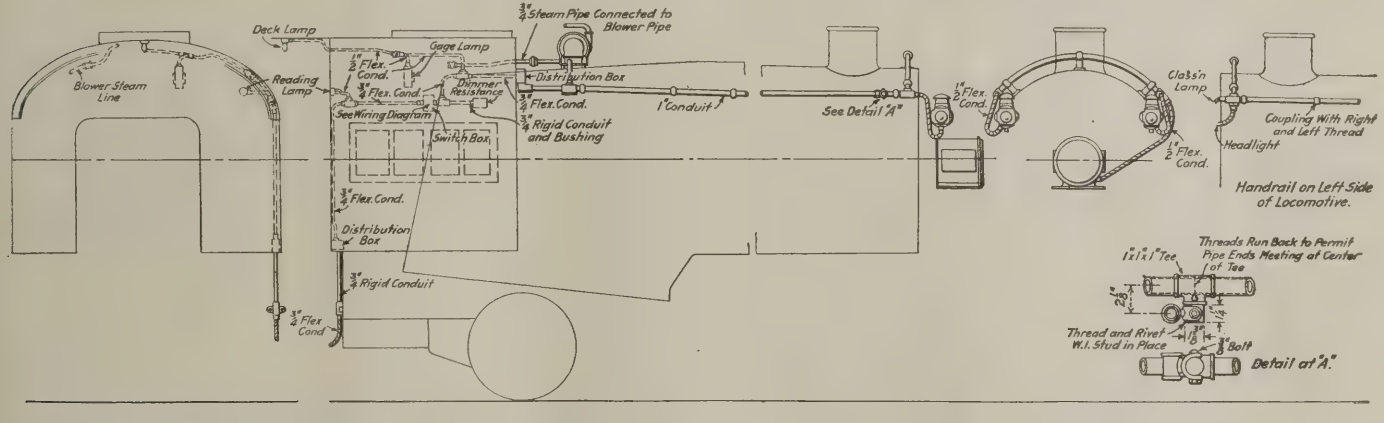


Fig. 1—General Arrangement of Headlight Wiring for Locomotives—Pennsylvania Lines West

The wiring diagram for locomotives in shuttle service is substantially the same as that for road service with the exception that the main switch is of the "one-off, two-off electrolier" type, in order to require only one dimmer resistance for both front and rear headlights and still permit them to be wired in parallel. The wiring

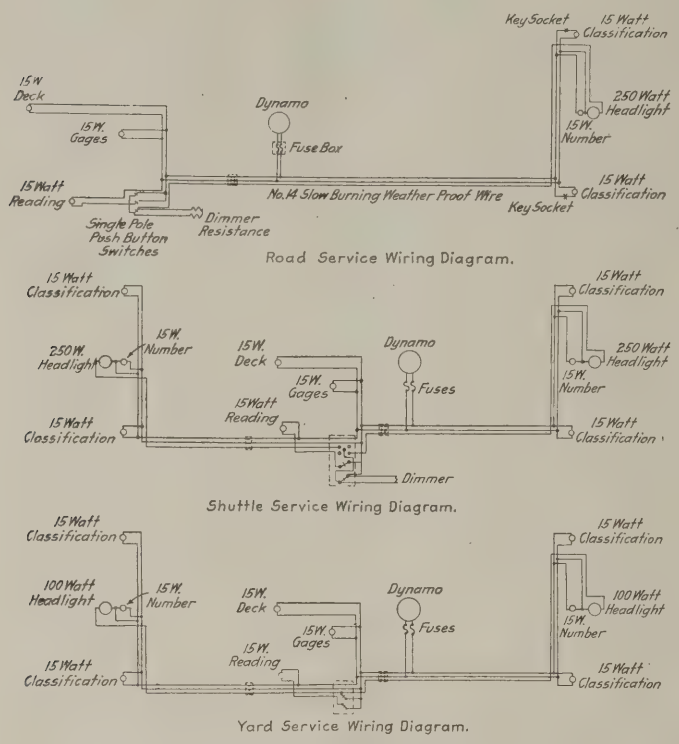


Fig. 2—Wiring Diagrams for the Three Classes of Service

diagram for locomotives in yard service is similar to that for shuttle service with the exception of the dimmer resistance, as headlights for this class of service are of less

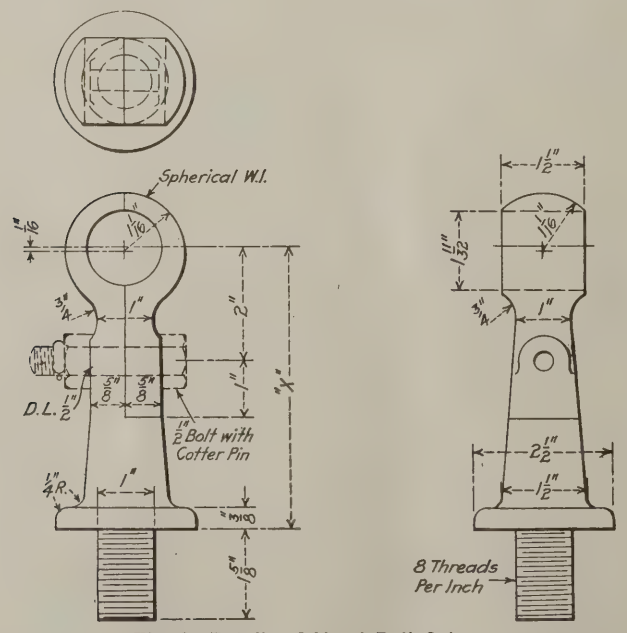


Fig. 3—Details of Hand Rail Column

intensity than those for road service and no dimming of the light is required.

The entire wiring is well protected from abrasion and chances of short-circuiting by a double sheathed conduit where it is exposed. The leads from the generator pass through a fuse box into a cast iron condulet, from which they pass back to a distribution box on the outside of the

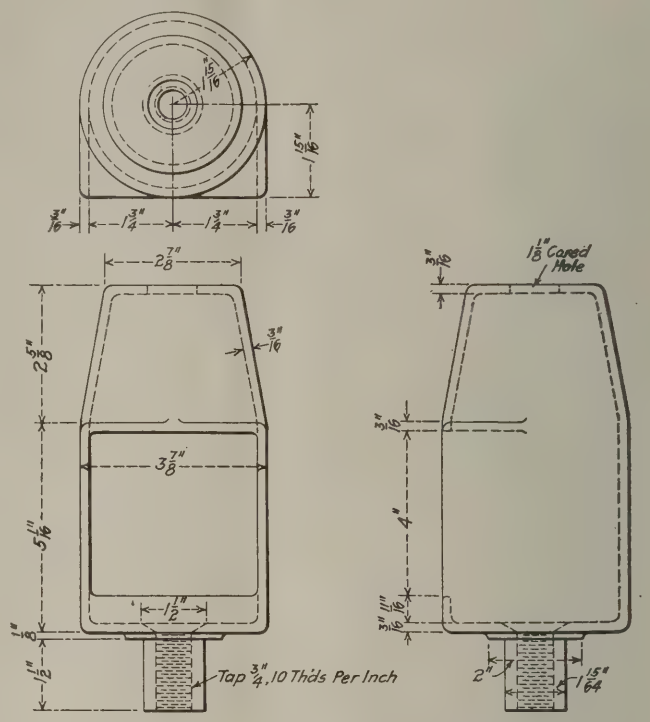


Fig. 4—Cab Lamp Used on Pennsylvania Lines West Locomotives

cab and forward through the handrail to the front of the locomotive. It is to be noted that condulets are provided at both ends of the handrail in order that the connections may be easily broken when stripping the locomo-

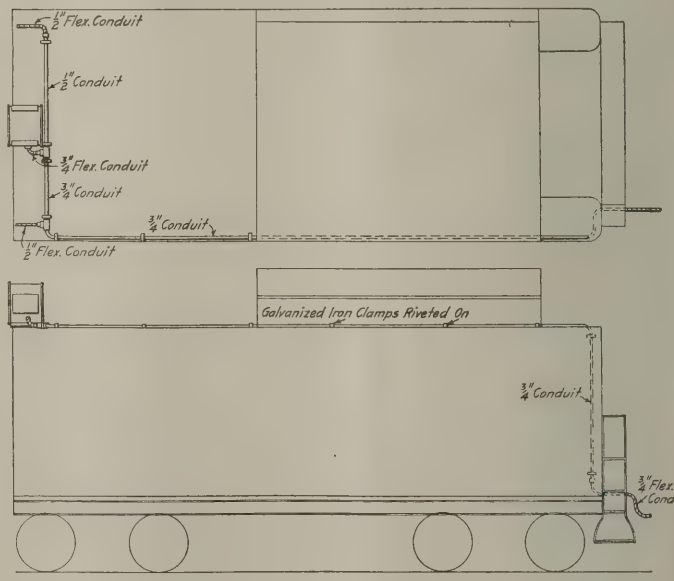


Fig. 5—Arrangement of Wiring on Locomotive Tender

tive. In fact, this principle has been followed throughout the entire system. It is also to be noted that the handrail columns have been modified. The column is split, as indicated in Fig. 3, to permit the easy removal of the handrail with the wires intact. At the front of the locomotive the wiring passes from the condulet to the right-hand classification lamp and also over the top of the boiler through the handrail to the classification lamp on the

other side and to the headlight and number plate, one-half inch flexible conduit connecting the headlight with the condulet. The locomotive distribution box is of a design particularly adapted to the service and is made by the Central Electric Company. This box is attached to the front of the cab, the wires from inside and outside

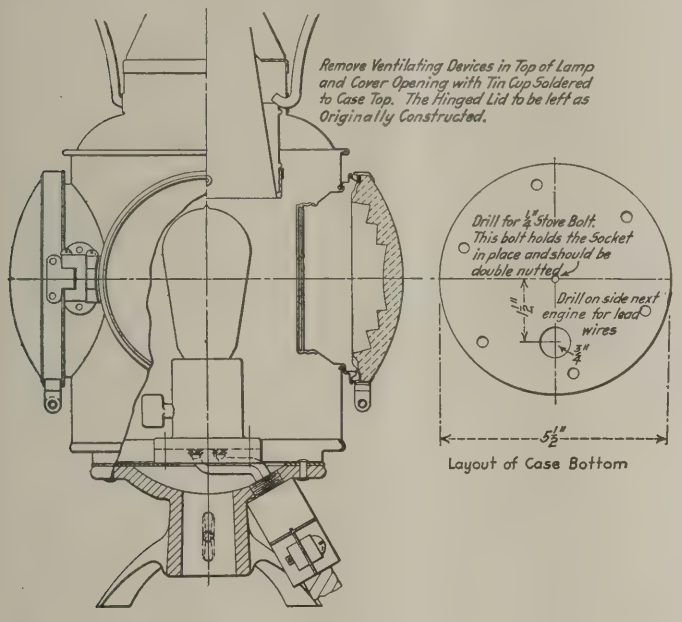

Remove Ventilating Devices in Top of Lamp and Cover Opening with Tin Cup Soldered to Case Top. The Hinged Lid to be left as Originally Constructed.
Drill for ¼" Stove Bolt. This bolt holds the Socket in place and should be double nutted.
Drill on side next engine for lead wires
½"
¾"
5½"
Layout of Case Bottom

Fig. 6—Arrangement of Classification Lamp for Electric Lighting

the cab terminating there, there being suitable connections for the wires. When it is desired to remove the cab from the locomotive the wiring both in the cab and on the locomotive can be left intact, the only operation necessary being that of disconnecting the locomotive wires from the distribution box. The cab wiring is run through flexible conduit attached to the roof of the cab. The cab lamp, which is shown in Fig. 4, is made of cast

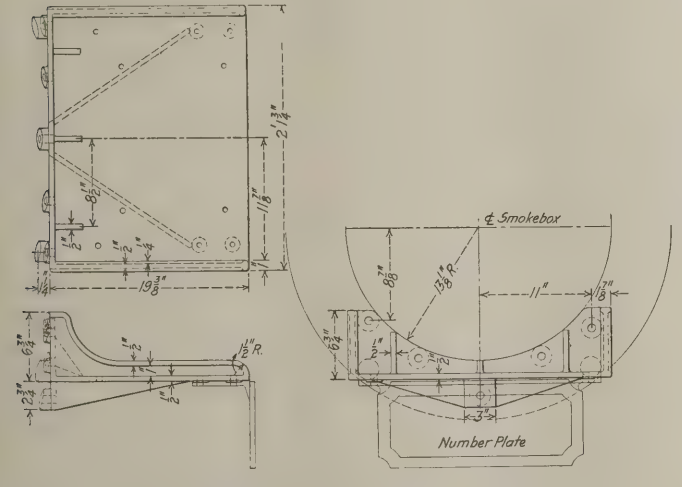


Fig. 7—Bracket for Locomotive Headlight

iron and it is held on a cast iron arm which is fastened to the backhead of the boiler and so located as to permit the rays of light from the lamp casing striking the water glass and gages. Only one lamp is used to illuminate the backhead of the boiler. The deck light has a spring grip socket and is located on the roof of the cab. The reading light, as stated before, is located at the side of the cab directly behind the engineer. On locomotives for shuttle and yard service the wiring passes through a ¾-in. flexible conduit down to the bottom of the cab where another distribution box similar to that at the front of the cab is located. The wires between the locomotive and tender pass through a ¾-in. flexible conduit up the side of the tender on the inside, and back to the light at the rear of the tender, as indicated in Fig. 5.

It was found necessary to make some changes in the construction of the classification lamp, which are indicated in Fig. 6. The bracket for the headlight and number plate is shown in Fig. 7.

ROUNDHOUSE WIRING ON MICHIGAN CENTRAL RAILROAD

Recently the standard practice for wiring of engine houses on the Michigan Central Railroad has been changed to conform with that shown in the illustration. The lighting circuit, which was three phase, four wire, 115 volts, was carried on the outside wall of the outer circle of the engine house on Pierce wall brackets, the distributing circuit being No. 6 weatherproof wire. Opposite each row of columns in the roundhouse a drop was taken from the distributing circuit, carried through a condulet entrance fitting and down on the outside wall to about 4½ ft. above the floor line where the conduit was carried through the wall to a Type F-S condulet where a switch was mounted from which the circuit ran through a condulet in which fuses for the protection of individual circuits were installed, thence through a lead covered cable in conduit to the first column, underneath the floor line. At this point the conduit was brought up above the floor line and connected by means of a condulet to a branch riser running up the column. The top of this riser was bent over to form a bracket bearing a Mazda lamp with bowl type reflector. A similar bracket was mounted on the opposite side of the column. From the opposite side of the column the conduit with lead covered cable was run under the floor and over past the next column to the second one where similar brackets were installed. This gave one light to each pair of columns and eliminated shadows from the columns, themselves.

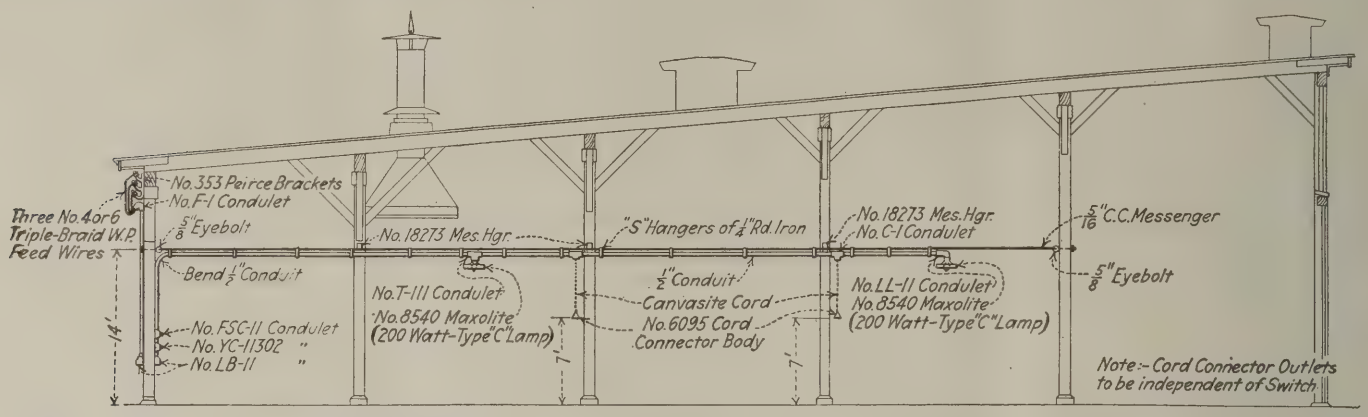
The objections to this method of installation were, first, the high cost of installation, due to the amount of labor required and, second, that a great deal of trouble was experienced with corrosion of the conduit underneath the floor line.

For this reason the method of wiring shown in the illustration has been adopted. In this method the entrance is made from outside the building just as in the former case; from the switch condulet, however, the conduit is carried up the inside wall through a type F-S condulet in which is mounted a fuse cutout. A copper clad steel messenger wire is suspended from the inner and outer circle walls used as a messenger for supporting the conduit, the top of the conduit being secured to the messenger by means of S-hooks. In the center of the space between every other column a type C condulet is used and on it is mounted a 200-watt type C lamp with metal reflectors. In addition a second type C condulet is mounted close to the column in the same space as that in which the lamp is mounted and from this condulet is

dropped a flexible reinforced cord with a receptacle mounted permanently, from which can be taken an extension line for work around the locomotives.

The lamps in adjoining stalls are staggered so as to give a uniform lighting; for instance, in one line of columns, reflectors and extension cords will be put in bays 1, 3 and 5, in the next line of columns lamps and extension cords will be arranged in bays 2 and 4.

It has been found that this method of lighting is easy



Method of Wiring Used in the Roundhouses of the Michigan Central. The Conduit Is Supported by Messenger Wire Below the Smoke Line and Little Trouble From Corrosion Is Experienced

to install, considerably cheaper than the methods formerly used, and, since all conduit is practically below the smoke line, very little trouble is experienced on account of corrosion.

LIGHTS THAT GREET OUR RETURNING SOLDIERS

"Say, Jim—" Out of the darkness came the suspiciously husky voice of a doughboy who was leaning over the rail of a returning troop ship.

"Do you—do you 'spose we'll get in to-night?"

"Aw, Gee, I dunno, but—ya bet I'm hoping hard. I ain't seen my goil in fourteen months."

"That's tough," answered the first boy.

Then after a pause, "I haven't any girl—no mother either. In fact, I haven't any home to come back to—except—except America."

Silence again for a few minutes.

"Gee, it's a *grand* old place to come back to, isn't it?" and in his enthusiasm he shoved his hands further into his pockets and gazed hard out into the darkness.

His little comrade, at a loss for words, murmured. "Sure it is."

The first boy began to reminisce quietly.

"'Member how we used to sing 'America' in school?"

"'I love thy rocks and rills
Thy woods and templed hills
My heart with rapture thrills
The sound prolong.'"

He sang it softly, almost under his breath.

"You know, a fella can *feel* that song after a taste of —over there."

"You're damned tooting," gulped Jim.

"And the lights of New York—" resumed the first boy in his low voice.

"Honest, Kid, I'm *longing* for them. Do you know what they mean to me?

"They mean the answer to prayers I guess we all said over there in those mud holes. They mean hope —and cheer—and—a—" he pondered to get the right word.

"—Home. Your girl will hug you till you'll think you'd have been safer in the trenches, but it'll be nothing to the welcome those light'll give me."

"Hold on, hold on," remonstrated Jim. "Who gave you a corner on de Gay White Way? I'm telling ye, Buddy, dem lights is *mine!* Didn't I fight like Hell for 'em? And haven't dey been boining steady and true every night to say 'Hello' to me de foist ting when I got back?"

"Oh, look—*look!*" cried Buddy. "Oh, Gee, Kid!" and he almost sobbed in his joy as he threw his arm around the little fellow's neck.

"See 'em, see 'em—over there—just coming out of the darkness? Didn't I tell you? Didn't I tell you they'd be there—shining 'Welcome Home' to us—the Lights of old New York!"—*Eye Comfort.*

APPRECIATION

If with pleasure you are viewing any work a man is doing,
If you like him or you love him, tell him now;
Don't withhold your approbation till the parson makes oration
As he lies with snowy lillies o'er his brow;
For, no matter how you shout it, he won't really care about it;
He won't know how many teardrops you have shed.
If you think some praise is due him, now's the time to pass it to him,
For he cannot read his tombstone when he's dead!
More than fame and more than money is the comment kind and sunny;
And the hearty, warm approval of a friend,
For it gives to life a savor and it makes you stronger, braver,
And it gives you heart and spirit to the end;
If he earns your praise—bestow it; if you like him, let him know it;
Let the words of true encouragement be said;
Do not wait till life is over and he's underneath the clover,
For he cannot read his tombstone when he's dead!

Railroad Electrification Facts and Factors

The Kind of Current and Supply Voltage Determine the Power Collecting Method Used

By A. J. Manson*

HAVING pointed out, in the preceding articles, the advantages of electrification and the benefits derived from the use of electric operation, and having made a comparison of the steam and the electric locomotive as regards tractive effort and horsepower, we are now going to take up electric locomotive design and discuss the construction and design of the various parts which go to make up the complete unit.

The electrical design of the locomotive will depend on the system of electrification with which it is to be used. The electrical systems may be classified under two headings as follows:—

(1) Direct current systems.

(2) Alternating current systems.

The direct current systems may be at either high or low voltage, varying from 600-700 volts up to 3000 volts. The alternating current systems may be either single phase or three phase with voltages from 3300 volts up to 11000 volts or even higher.

The collection of the electric power for operating the locomotive is one of the important and interesting points. Electricity for transportation was first used on the street railways. An overhead trolley, carrying 500 volts direct current was used. As greater loads were demanded, due to the operation of more and larger cars, it was necessary to provide greater capacity in the trolley wire for carrying the required current. The capacity of the wire was limited so that copper feeders were installed in parallel with the wire. When steam railroads operating heavy train service were electrified using direct current at 600-700 volts, a power greater than could ever be delivered by the wire, was required, so that the third rail contact system was used to provide the necessary current carrying capacity.

In a typical third rail contact system, the power is generated at a central power house and transmitted out to the substations as high voltage three phase alternating current. At the substations this three phase power is reduced by transformers and then changed by rotary converters into direct current. This direct current is distributed from the substation to the third rail by feeders. Ordinarily the track rails are used for the return current, but in the case of heavy systems, copper cables, known as negative feeders, are connected in parallel with the rails so as to reduce the voltage drop, back to the substation.

There were limitations to the third rail system. While in very dry climates 1200 volts can be used on the third rail, it may be said in general that this system of electrification is one of 700 volts. The comparatively low voltage, where heavy train service exists requiring considerable horsepower, means an abundance of copper, substations, etc., to care for the heavy current necessary for the operation of the numerous heavy trains over long distances. Naturally to eliminate the excessive copper and substations a higher voltage was required. Subsequently, the overhead contact system, using high voltage single phase or three phase alternating current, was employed and recently high voltage direct current has been used on the overhead system with success.

In typical single phase systems, the power is transmitted at high voltage to the transformer substations, where it is transformed down to the workable voltage and connected directly to the overhead contact system as single phase current.

In the case of the three phase system, three phase power instead of single phase is delivered to the locomotives. This requires that two contact wires insulated from each other be placed above the track, the rails forming the third wire.

The high voltage direct current overhead system is similar to the low voltage direct current third rail system. The power is transmitted in the same way, converted by rotating machinery, but is fed at high voltage to an overhead conductor instead of to a third rail.

Besides the internal apparatus of the electric locomotive being designed according to the system over which it will operate, there is another fundamental point of difference which lies in the method employed in the collection of the current. From this point of view, the locomotives can be classified under two headings:—

1. Those equipped with pantagraph trolleys to collect the current at high voltages from overhead wires located several feet above and directly over the track.

2. Those equipped with third rail shoes to collect the current from conductors located alongside of and adjacent to the running rails.

Before describing the design and construction of the overhead and the third rail collecting devices, it seems advisable to consider the construction and location of the electric conductors—namely, the overhead and the third rail trolley.

With either type of construction, the conductor must be insulated to prevent leakage of the electric current, and so located that there will be the minimum interference with existing structures; that there will be no interference with the rolling equipment and that it will permit of safe and satisfactory operation of the electric locomotives.

The clearance for overhead working conductors, as recommended by the American Electric Railway Engineering Association, is shown by Fig. 1. These diagrams show minimum clearances for five different cases. They are made up from the data Table I, tak-

*Westinghouse Electric & Mfg. Co., New York.

ing into consideration the clearance necessary where trainmen are required to give signals by hand and by lantern. The height of wire above the top of the running rails is thus determined. It is an advantage from the standpoint of the pantagraph trolley construction to keep the wire lower than the 24 feet. Many times overhead bridges span the tracks so that

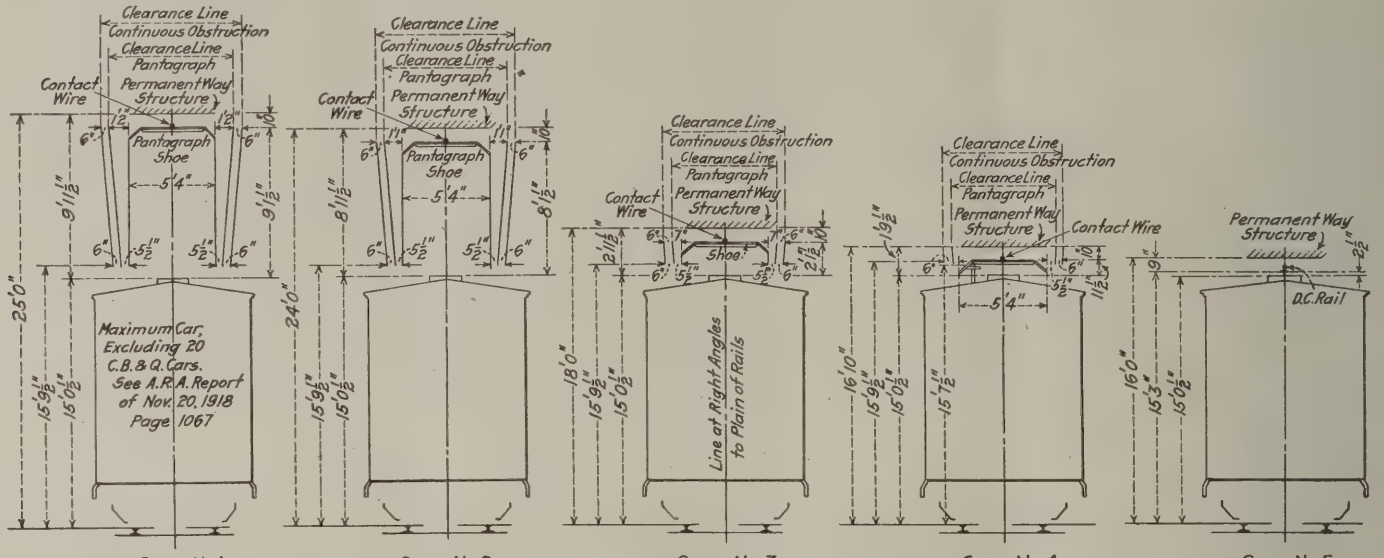


Fig. 1—Clearance for Trainman Giving Lantern Signals

Clearance for Trainman Giving Hand Signals

Normal Minimum Clearance Without Trainman on Cars

Special Minimum Clearance for High Voltage Wires Without Trainmen on Cars

Minimum Clearance D. C. Overhead

cases 3 and 4 show the normal minimum clearance and the special minimum clearance.

The clearance lines take into consideration the sway of the pantagraph and its variation from central position. For instance, the car springs may have a maximum difference in height of 1 in. There may be a ½ in. difference in elevation of track rails. The pantagraph, being constructed of Shelby tubing, with all joints as free from friction as possible, will sway at high speeds. The amount of swaying will depend on the height of the wire. In arriving at the width of shoe, namely 5 ft. 4 in. and in locating the clearance line, this sway is assumed as 6 in. either side at twenty-two feet above the top of the running rails. It will be noted that as the wire becomes lower the clearance line approaches the width of the shoe. If special designs are used then additional clearances may be necessary as these diagrams show minimum clearances. Case 5 covers location and clearances of the D. C. overhead conductor. Many times, in yards, it is impossible to locate the third rail with reasonable length gaps, so that an overhead rail is put up, collection of current being made by a short, iron pantagraph collector. In the case of the high tension, the pantagraph collector must be so designed that it will adapt itself to the various heights of wire shown in cases 1 to 4 inclusive.

The third rail system consists of a conductor placed alongside of the track at a fixed distance away from the running rail and slightly above it. The location of this rail has become more or less standardized.

There are two different types, the over-running or top contact third rail and the under-running or under contact third rail. In either case the rail is supported by means of insulators at intervals of about ten feet

TABLE I

Dimension	Case 1		Case 2		Case 3		Case 4		Case 5	
	Clearance for trainman giving				Normal minimum clearance without trainman on cars		Special minimum clearance for high voltage wires without trainman on cars		Minimum clearance for 600-volt d-c overhead contact wires	
	Lantern signals		Hand signals							
	Feet	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*
Distance between wire or face of contact rail and structure	0	10	0	10	0	10	0	10	0	9
Desirable clearance between rolling stock and wire, or contact rail	—	—	—	—	2	1½	0	11½	0	2½
Reach of 6 foot trainman	7	8	7	8	—	—	—	—	—	—
Lantern, height of	1	0	—	—	—	—	—	—	—	—
Clearance	0	5½	0	5½	—	—	—	—	—	—
Total clearance above car	9	11½	8	11½	2	11½	1	9½	0	11½
Height of car	15	0½	15	0½	15	0½	15	0½	15	0½
Height of permanent way structure	25	0	24	0	18	0	16	10	16	0

Some sort of guard or covering is provided to prevent accidental contact with the third rail and also to eliminate trouble due to snow and sleet. The third rail is generally a low carbon steel, much lower than used in the track rails and it has therefore a low resistance. In other words, it is of high conductivity. The rail sections are joined by fish plates and to insure electrical continuity, are bonded with copper bonds.

The location of the typical over-running third rail in reference to the track is shown by Fig. 2. The in-

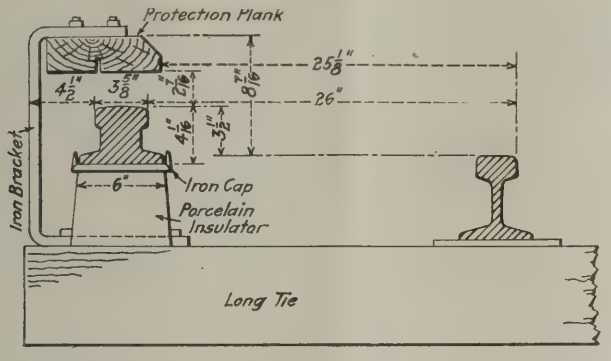


Fig. 2—Sectional View of Over-Running Third Rail Showing Its Relation to the Track

sulators supporting this third rail rest on long ties placed at intervals of about ten feet. The type of insulator shown is a block of porcelain and sets over a short pin, screwed into the tie, which keeps the insulator located. On top of the insulator is placed an iron cap to hold the rail. No clamping or fastening of the rail is done, as the weight of the rail is sufficient to hold itself in place and not turn over except in cases of derailment when it is distinctly an advantage. Little damage is done and the rail can be replaced quickly.

The under-running third rail layout is shown by

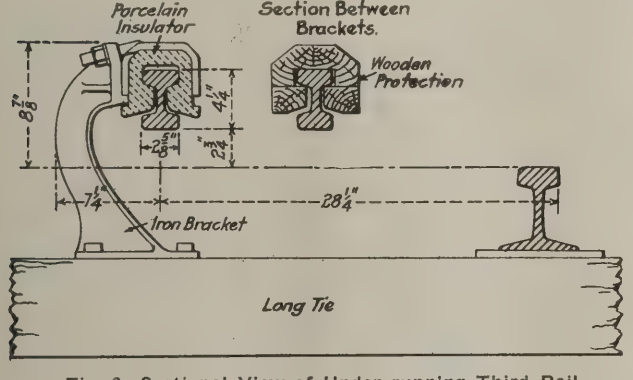


Fig. 3—Sectional View of Under-running Third Rail

Fig. 3. As in the case of the over-running rail, it is supported every ten feet from long ties. The method of support is not nearly as simple as the over-running rail. A curved bracket is required. The rail is held or suspended from insulators each consisting of two halves clamping around the rail for a length of approximately eight inches, and held together by a clamp bolted to the bracket. Wooden strips are placed around the rail except on the bottom surface, as a means of protection, shown in the figure as "section between brackets."

From the above description of the location of the electric conductors an idea can be formed as to the problem to be met in the collection of the electric power. In the case of heavy electric traction large horsepower is developed per unit which, in turn, means the collection of a large number of kilowatts from the conductor at almost any speed from start to over 60 miles per hour. When taken from the third rail the power is of low voltage and very high current, but can be collected easily by the third rail shoes. In the case of the high voltage alternating current system the voltage is high and the current low, so that by providing proper clearances and insulation for the high voltage it is equally easy to collect the power. The current required with the high voltage direct current system, having a maximum voltage of 3000 volts in this country, is considerable. While 3000 volts cut down the current demand, still considerable current must be handled and more or less special provisions have been necessary in connection with its collection.

In our next article we will take up in detail the construction of the current collectors, considering first, the pantagraph for both alternating and direct current collection and second, the third rail shoe.

ELECTRICALLY OPERATED DEEP-WELL CENTRIFUGAL PUMP FOR RAILROAD SHOPS AND YARDS

The electric pumping equipment, lately completed, to serve the shops and yards of the Oregon-Washington Railroad at Albina station, Portland, Ore., is typical of the modern deep-well multistage centrifugal pump direct-connected to a high-speed motor, vertical type, having automatic starting through contactor panels. The water is pumped from two caissons sunk 40 feet to allow inlets thereto from Willamette River and is discharged directly into pressure mains below the shop and yard surface.

The two steel caissons, each 54-in. diameter, extend from the floor level of the pump house to 4 ft. below zero stage of water in the river, there being a 10-in. connection between them near the base. A 10-inch inlet was extended from one of the caissons into the stream.

Each caisson contains a Byron Jackson, 8-stage centrifugal pump of the rated capacity of 650 g. p. m., and is direct-connected to a 75-hp. vertical-type motor, wound for 3 phase, 60 cycles, 440 volts, and having a speed of 1200 r. p. m. The motors are equipped for automatic starting through contactor panels, those operations being by air pressure in pipes through pressure gages and relays mounted upon the control panel. The plan is to operate only one pumping unit at a time, except in case of fire or other necessity, and by the use of a double-throw 4-pole switch it is possible to alternate the motors and thus equalize them in service. The starting panels are provided with power-limiting relays to protect the motors, and also inverse time-limit relays.

There is an 8-inch discharge pipe leading from the pump in each caisson to the surface line, where the discharges from both pumps form a Y and unite in a pipe line that contains an 8-in. Neptune meter from which the water passes on into the main supply line. There are, however, by-passes around the meter, with valves controlling the flow of water.—*Electrical Review.*

The Trials and Troubles of a Car Lighting Man

Hinkey Dee Has Some Interesting Experiences During His First Two Days on the Job

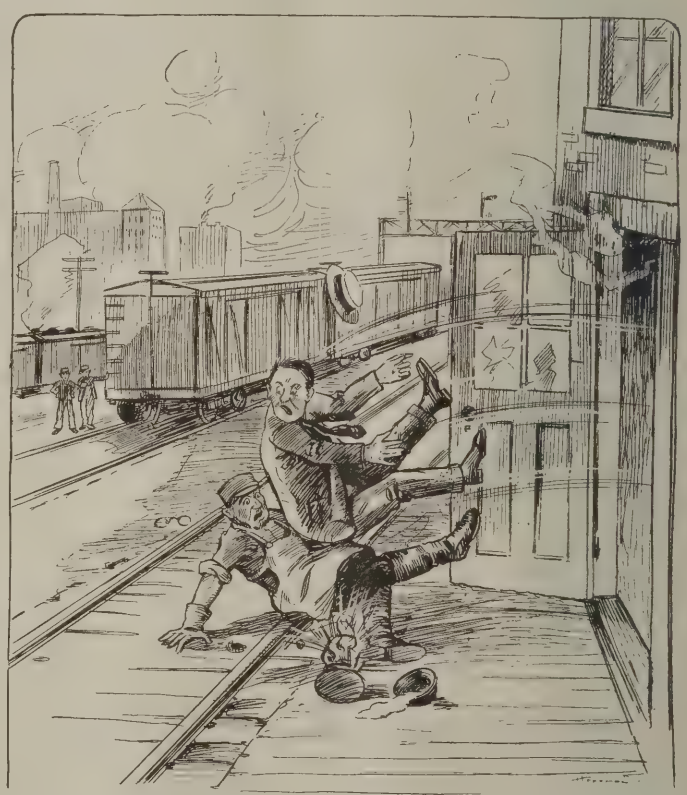
GREAT Balls of Fire! It makes me smile when some fellow tries to show me somethin' in car-lightin'. Me with a good brain and years of good sound practical experience and some saphead that has nothin' but an education comes along and tries to tell me somethin' I don't know about an axle generator. But they don't bother me much any more since they found that I was born with an axle generator in my hand. At least, I'm known on all the railroads as "Hinkey Dee, the electrician, who was born with an axle generator in his hand." It's all in the way a fellow starts, and there's only one way to start, and that's the right way. Believe me, you have to start right and put your shoulder to the wheel if you want to be good like me on car lightin'.

I made up my mind the very first day I started to learn car lightin' that I was goin' to learn everythin' that there was to learn in car lightin', and I'll never forget the hard road I had to travel at the start. The first day I wanted to make a good appearance, so I wore my best suit, a light mixed swell suit, green natural silk shirt, red changeable silk necktie, new straw hat with lavender band and yellow buttoned shoes, and say, fellows, maybe I didn't look nice. Two chickens followed me all the way to work. They remarked, "Oh, look who's here!" "Ain't he grand!" "Wonder who dressed it and sent it out!" "Oh, Death, where is thy sting!" "If I only had a wet onion!" But I didn't weaken a bit; I knew they were just tryin' to gain my affections, and I made up my mind that no girls was goin' to make a fool out of Hinkey Dee.

The minute the boss saw me he smiled. I knew by the way he laughed that I had make a hit and that he liked me. I said, "Good mornin'. I'm Hinkey Dee and I'm goin' to work here." "Oh, yes," he remarked, "I have heard a lot about you. Did you fetch any workin' clothes to work in?" I said, "Yes, I'm all ready." He said, "What! Are you going to work in those good clothes?" I said, "Yes, sir. I want to start at my best."

He started me helpin' a fellow fixing batteries. We fixed the insides as well as the outsides, but I could tell this fellow didn't like me very much. He got so mad at me for doing nothin' that he said, "Say, Hinkey Dee, if hot air was music you'd be a whole brass band." But I just kept on asking him questions and didn't get a bit discouraged. I knew he was jealous of the way I was learnin' and of how nice I looked. Why, he was so jealous he didn't want me to even look in the batteries when they were chargin'. I just knew that there was somethin' in them when they were on charge that he didn't want me to see, so I made up me mind when I had a chance I was goin' to look. Just then he turned his back and I reached over and looked. I saw a million little things like soap bubbles swimming around in the battery, but I was afraid to look too long for fear he would turn around and catch me.

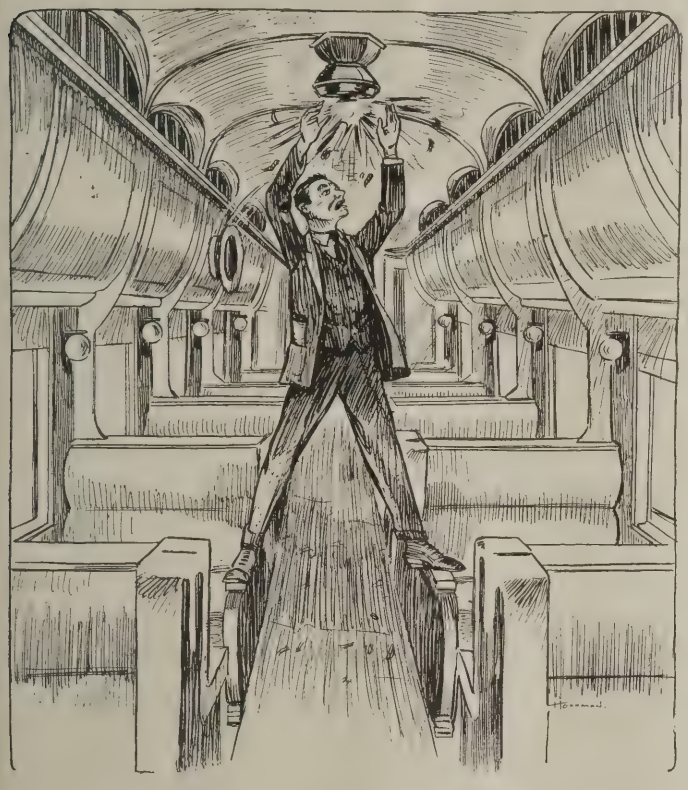
Well, the old saying—Everything comes to the man who waits—come true. The fellow I was helpin' left his lunch on the window-sill and a sparrow came along and conveskated it. Then the big stiff was without any eats and had to go out to a restaurant or starve. While he was away the thought flashed through my head, "Hinkey Dee, now's your chance to see what's inside the battery that makes them charge." Over I goes to the battery and looked in. I saw the little things like soap bubbles goin' in all directions. Gosh whiz, they were busy; but it was so dark in the battery I couldn't see just where the soap bubbles were comin' from, so I struck a match and looked in. BING! BANG! Well, fellows, I don't like to brag, but it takes the experience to see what I saw then. The battery went off just like a squad of 14-in. guns firing a salute. It just seemed to me that the battery turned inside out, and the whole building moved and left me standing there. I was hit so many places at the same time that I didn't know if I was hurt or not. The door was closed, but I went flying through it just the same. To make matters worse, the boss was passing just as I was going through the door and we got so tangled



"The Door Was Closed But I Went Flying Through It Just the Same"

up that one of the fellows said he didn't know if we were fighting, tryin' to do the tango on our heads, or imitate some acrobats we had seen in some circus. By golly, but the boss was mad. We stumbled over a gasoline torch that was heating a pot of lead. It exploded and hit the boss square in the seat of the trousers. His trousers caught fire and, great Cæsar's ghost, how he

run—it took the fastest runner in the gang to catch him so as to put him out. During the mixup the boss lost his false teeth and broke his glasses, and that made him wild. I tried to explain to him that somebody must have put dynamite in the battery, but he wouldn't have it that way. He called me everything he could think of or ever heard of and some things that he never heard of, but I didn't get a bit sore. He said I was the dumest man he ever saw and that I had better sneeze because my brains were dusty. He said, "Why, you poor simp,



"This Time the Lamp Exploded and Fell All Over Me. Then I Got Mad"

you ignited the gas in that battery with a lighted match and caused it to explode," but he couldn't kid me even if it was my first day. My nice new suit was so full of moth holes from the soap bubbles in the battery you'd think somebody had been riddling me with bullets from a machine gun. To tell the truth, I think that's where they got the idea about porous underwear.

After we got bandaged up and I told the boss I would pay for a new seat in his trousers, his glasses and false teeth, he seemed in a little better humor and said, "Hinkey Dee, your so interested in seeing the batteries charge I think I'll give you a chance to charge some." He said, "Suppose you go in the yard with Jimmy Goat and let him show you how to inspect the lights in the cars, take voltage tests and charge the batteries." I told him that was fine and that I wanted to learn all about car lightin'.

Jimmy Goat took me around and showed me how to turn the lights on in the cars, how to take voltage tests at the switchboard, how to plug the cables in the side of the car so's to charge the battery. He told me if I found any cars with broken or burned out lamps that I was to take the bum lamp out and put in a new one.

I learned so quickly that the very next day Jimmy said, "Say, Hinkey, you're doin' great—why, your doin' so good I'm goin' to let you take half of the yard and I'll take the other half." I told him I was always bright and quick to learn and that I had inherited my wisdom from me father. He asked me what me father was, and I told him that before he died he was the head janitor in a machine shop.

Then I started out all alone. Now wasn't that goin' some. To think I learned all about it in one day. The first car I inspected I found a lamp was broken, so I unscrewed the lamp, went to the stock-room and got a new lamp. When I tried the new lamp in the socket it flashed like lightin' and then wouldn't light any more. So I got another new lamp and tried that. This time the lamp exploded and the glass fell all over me. Then I got mad. I made up me mind that I'd get a lamp to stay lit in that socket if they all busted, because I didn't want Jimmy Goat to know that I didn't know what was the matter with it. I tried all the lamps there was in the box and they all exploded. Just as I was going to the car with the last lamp I bumped into Jimmy Goat. He said, "What's the matter, Hinkey? Have you got the walkin' typhoid fever? I have seen you make fifty trips between that car and the stock-room within the last ten minutes." I saw that he had me with the goods, so I decided to explain the trouble and see if he could tell me what was wrong with the darn old socket. Soon as Jimmy saw the last lamp explode and all the lamp butts lying around on the floor, he started to laugh, and if there's anythin' in this world that gets my goat quicker than that I'd like to know what it is. Yes, I hate any one to laugh at me when I know what I'm talking about. He said, "Say, Hinkey, what box did you get those lamps from?" I said, "Why, the big box just inside the door." Then he let a howl out of him and took a fit of laughin'. I got mad then and declared meself. I said, "Lookey here, Jimmy Goat, don't you think for one minute that you can make a darn fool out of me. If it's such a good joke, what is it?" Then he said, "Hinkey, your a mess; if your head was made to fit your brain you could wear a thimble for a high hat." He said, "Why, they were 30-volt lamps you were putting in a 60-volt car." Gosh, that was a relief to me mind. I sure was glad to know it was the fault of the lamps and not me. I thought to meself if these electrical engineers would make all the lamps fit all the cars, then the lamps wouldn't be busting when you put them in a car. But I guess it's wrong to expect electrical engineers to do everything right. Jimmy found a lamp for me that would stay lit in the car, then I went to work putting the car on charge. I found a cable with a round thing on each end and looked at both ends good to see that they were alike, because I made up me mind to keep up the good work and be careful. I plugged one end into the hole in the yard and the other end into the hole on the side of the car. Just as I'd put the plug in the car the electricity flashed just as if it was anxious to get into the car before I had the plug in, so I pulled it out again, rested a few minutes and then jabbed again. This time it flashed and looked just as if the sun had come out. I pulled the plug out again and was just making another jab when Jimmy Goat came along. He said, "Why don't you get this car on charge?" I said, "You stick around and you'll see." I jabbed again and Jimmy let one yell out of him. He said, "Stop jabbing that plug in the water tank spout." Then I discovered my mistake; but anybody

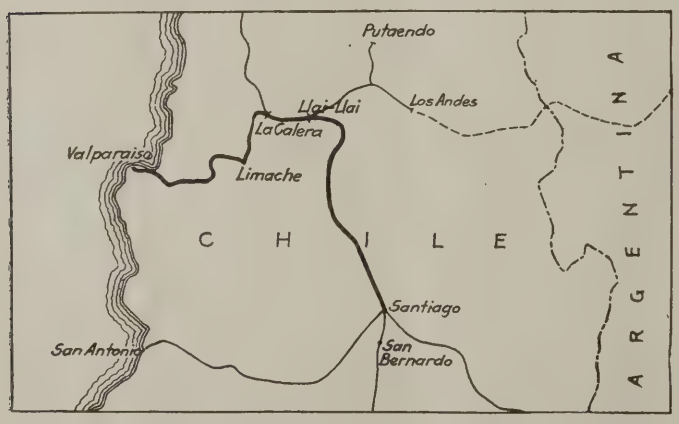
would make a mistake like that, because the hole wasn't marked so's you'd know where the plug belonged. I told Jimmy I was going to ask the boss to have all the holes marked, but he told me my best bet was to keep out of the way of the boss, because the boss had said, "If Hinkey Dee annoys you any more today, he will only need one more clean shirt." So I took Jimmy's tip and kept away from the boss.

THE PROPOSED CHILEAN ELECTRIFICATION

Further details are now available concerning the visit to this country of two prominent Chilean engineers to continue their investigations of the proposed Valparaiso and Santiago electrification, briefly noted in the general news section of the February issue.

The two engineers are Rafael Edwardes and Ricardo Solar. Mr. Edwardes has been connected with the Chilean State Railways for several years as a consulting engineer in electrification. He is a professor of electrical engineering at the Catholic University at Santiago. Mr. Solar is a civil and electrical engineer and is the head of the laboratory of electrical engineering in the State University at Santiago. They are expected to arrive shortly and will have their headquarters at the office of the Chilean State Railways, 141 Broadway, New York.

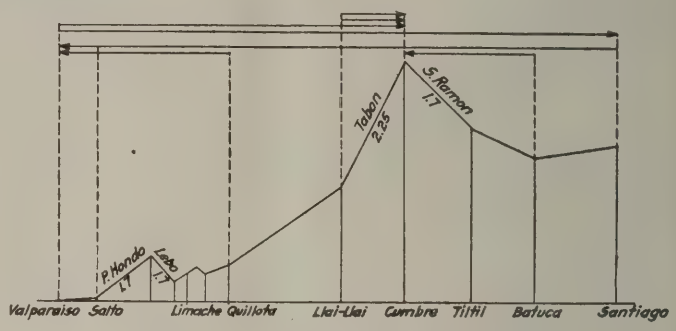
The line which it is proposed to electrify is that from Valparaiso, Chile's principal seaport, to Santiago, the capital, and is 116 miles in length. It is a part of the first zone of the state owned Central Railway and consists in reality of an important branch from Valparaiso inland to La Calera, 43 miles, connection being



Map Showing the Proposed Chilean Electrification. The heavy line shows the portion which it is proposed to electrify, and the light lines the connecting lines of the State Railway system. The broken line eastward from Los Andes is the Transandine Railway.

made at La Calera over the main line itself to Santiago, making the other 73 miles. The line is of 5 ft. 6 in. gage. It is double tracked from Valparaiso inland to Llai-Llai and single track only from there to Santiago. As shown on the profile there are four heavy grades. The highest point on the line is at Cumbre, about 2,400 ft. above sea level. To surmount this there is the Tabon grade against traffic towards Santiago, 16 miles in length and of 2.25 per cent. Traffic towards Valparaiso on the other side meets a grade of 1.7 per cent on the S. Ramon grade, about 11 miles long. Just inland from Valparaiso are the Paso Hondo and Lebo grades against traffic from and to the seaport, respectively, both 1.7 per cent.

The traffic handled over the line is of miscellaneous character and is fairly evenly balanced. Between Llai-Llai and Valparaiso the average daily freight train tonnage handled amounts to 4,316 inland and 4,127 towards Valparaiso Between Llai-Llai and Santiago the traffic is less, 3,832 tons being handled towards Santiago and 3,175 towards Llai-Llai. The trains average about 450 tons. All trains over 300 tons are doubled-headed. Trains from Santiago to Valparaiso require pusher locomotives from Batuco to the top of



Profile of the Proposed Chilean Electrification

the S. Ramon grade at Cumbre and between Quillota and Valparaiso. Those inland from Valparaiso require pusher service inland as far as Llai-Llai, with additional assistance up the Tabon grade to Cumbre. The locomotives used are Consolidations weighing 62 tons on drivers, and Mikados weighing 72 tons on drivers.

The principal reason for the proposed electrification is the high cost of coal and to a lesser extent to increase the capacity of the stretch of single track from Llai-Llai to Santiago, physical conditions very largely preventing double tracking. Bituminous coal at present costs $24 a ton in Chile, and even in normal times costs as high as $12 to $14. For the proposed electrification water power is available from the Aconcagua river, which parallels the railroad for a considerable distance. It is proposed to put the generating station at a point on the river approximately 30 miles from Llai-Llai.

It is hoped that electrification will permit of 500 ton trains with a speed on the heavy grades of 16 to 18 miles an hour. Passenger trains will make a speed of about 30.

Railroads in Great Britain.—For years the trades union movement of Great Britain has been committed to public ownership of railroads. It is said that while it is still for this, nevertheless there is a cooling down, due to the fact that government management of the British railways as a war measure has already resulted in a loss of $200,000,000 on less than 24,000 miles of lines. Also, a large number of the English middle class were formerly in favor of the socialization of the rails. It is reported now that the middle class is practically solid against any public ownership of the railways, and that there is a fair prospect of its defeat.

Elements of Practical Electricity

A Series of Articles Prepared for the Benefit of the New Men in the Railroad Electrical Field

X.—Direct Current Motors

IN other articles of this series considerable space was devoted to the description and explanation of the direct current generator. The direct current motor does not differ in appearance from the generator, in fact it is entirely possible to use a generator to perform the function of a motor if it be so desired, and indeed a number of electrical devices make use of this very fact—that the functions of a generator and a motor may be performed by one and the same machine.

It must not be supposed, however, that machines which are designed for the purpose of generating electricity are commonly used as motors. Both the generator and the motor contain practically the same parts, but the designer of each machine keeps in mind the primary

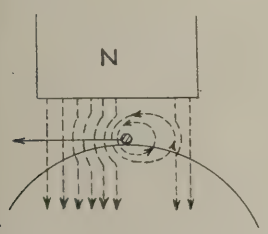


Fig. 1—Generator Action

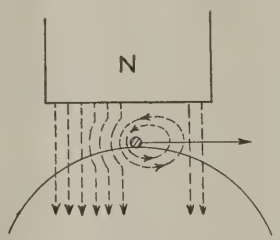


Fig. 2—Motor Action

purpose for which it is to be used. Generally speaking, it is more usual to find generators designed in larger units. Motors used for power purposes are designed in an infinite number of sizes from fractional horsepower rating up to large motors of several thousand horsepower.

The principle of convertibility when applied to changing a motor into a generator does not always succeed with the smaller types of machines. For example, a small direct current motor, such as would be used in running an electric fan cannot usually be changed to operate as a generator with any degree of success. The reason for this is that it is impossible for the machine to build up a strong magnetic field from the current developed in the armature, and hence the machine which may operate perfectly as a motor fails absolutely when an attempt is made to use it as a generator.

Nevertheless, the chief differences between generators and motors are more a matter of use than of construction. The generator is a machine designed for the purpose of generating electric current. The motor is a machine designed to develop mechanical power when it is connected to an electric circuit. There are a number of interesting things to be learned in connection with the operation of direct current motors, and no discussion of elementary electricity would be considered complete without some reference to the operating peculiarities of these useful machines.

Analysis of Motor Action

The direct current motor depends for its operation upon a continuous supply of current from the lines to which it is connected. To understand how this current produces rotation of the motor armature and hence develops power may best be accomplished by reducing the construction of the motor to its simplest component parts. For the sake of comparison the action of the direct current generator is shown in Fig. 1, while the direct current motor action is illustrated in Fig. 2. An inspection of these two illustrations will show that they differ only in one respect, that is, in the direction which the conductor on the circumference of the armature is being moved. Only one conductor has been shown in these sketches for the sake of clearness, but it might be well to keep in mind that the effect produced on a single conductor is multiplied many times in the actual machine. The current in the conductors in both of these sketches is indicated as flowing away from the reader, by the direction of the magnetic field which surrounds the conductor. In the sketch illustrating the generator action it is assumed that the armature is rotating in a counter clock-wise direction, in which case the conductor shown will move toward the left. It is while moving in this direction that the current is generated in the conductor and that the magnetic field which opposes the force that develops it, is established around the conductor. In other words when the conductor in Fig. 1, is moved as shown, it encounters opposition. The fundamental principle of motor action is shown in Fig. 2. In this case the current which flows in the conductor is not developed in the machine itself but is supplied from some external source. Its direction is assumed to be the same as in the case of the conductor in Fig. 1, and the magnetic field surrounding the conductor is therefore in the same direction also. It will be remembered that there is no mechanical force applied in the case of the motor as was with the generator. Current is simply supplied to the machine. It will be noted that the field which is established around the armature conductor in Fig. 2, has the same direction as the field which emanates from the pole piece, on the left side of the conductor. On the right hand side of the conductor, however, the field due to the current in the conductor opposes that emanating from the pole piece and thereby neutralizes it to a certain extent. The direct result of this combination of magnetic fields produces a strong field at the left of the conductor and a weak field at the right and as a result of this unbalanced magnetic condition, the conductor is forced from the region of the intense field, toward that of the weaker field. As subsequent conductors move into place, each is acted upon in the same manner and the resulting effect is that the armature rotates.

This pushing of the armature conductor is dependent upon a number of things. In the first place it is proportional to the strength of the current flowing in the conductor. The amount of push is also dependent upon the length of the conductor and the strength of the magnetic field coming from the pole piece. This applies to

a single conductor, but since all armatures are composed of numerous conductors it is evident that the force which causes rotation will also be proportional to the number of conductors that are being acted upon. The combined pushing or pulling action of the magnetic field upon the armature conductors results in a twisting or turning effort of the armature which is very commonly spoken of in connection with motors as *torque*. Just what is meant by torque will be best appreciated if the following experiment can be tried. Grasp with the hand the pulley of a small motor and send current through the armature while the field is excited. It will be found that there is a strong twisting action, a tendency to turn, which is produced by the action of the magnetic fields upon the conductors. It is this tendency to turn that is known as torque.

In a general discussion on the subject of motors the term torque will be frequently used. It is a term which gives the comparison between one motor and another, and in order to do this some unit which represents the magnitude of the torque in each case must be used. The unit that has been adopted for this purpose is the pound foot. Torque is therefore expressed in pound feet and the methods for determining by actual test the torque developed by any motor will be of interest.

The device shown in Fig. 3 is known as a Prony brake.

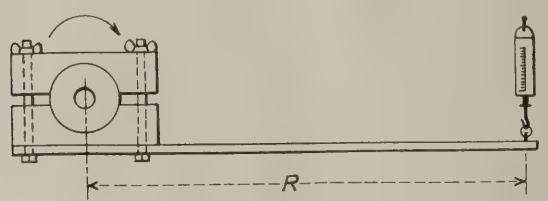


Fig. 3—The Prony Brake

It consists of two blocks of wood which are partly rounded out as shown. These are clamped to the pulley of the armature shaft by tightening the wing nuts on the ends of the two bolts. To one of the blocks is attached an arm which extends outward perpendicular to the armature shaft. At a fixed distance from the center line of the shaft a hook is placed in this arm to provide means for attaching it to a spring balance. If the armature is rotated in the direction indicated by the arrow, and the wing nuts are tightened on the blocks it is evident that as the pressure increases on the pulley there is a tendency for the arm to rotate in a clockwise direction. The arm is restrained, however, by the spring balance and the amount of force required to prevent it from turning is registered in pounds upon the scale. This record in pounds is one of the factors of the motor torque; the other factor is the length of the arm from the center line of the shaft to the center line of the spring balance, in feet. The torque of the motor then is the product of the pounds registered upon the spring balance and the length of the Prony brake arm in feet. In using the Prony brake care must be exercised, of course, not to tighten the wing nuts too much, for if this is done the armature pulley may be so firmly gripped with the blocks that it is prevented from turning at all.

Motors are designed with a low torque or a high torque according to the uses to which they are put. A motor used for the purpose of driving a blower fan, or other similar high speed apparatus does not require a high torque. A relatively small amount of effort is required in starting such a device and the power of the motor is used in the production of high speed. On the other hand large and intricate machines having many heavy parts which require simultaneous or intermittent motion require a motor which has a high torque. One example of this kind is found in the modern printing press. An exceedingly large torque is required to start such a large piece of machinery. Motors used on electric cars are also of the high torque variety. The reason for this, of course, is that there is a tremendous effort required to start such machinery.

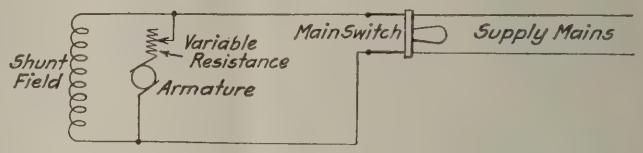


Fig. 4—Wiring Diagram Showing Location of Starting Resistance

Flow of Current in Motor Armatures

The resistance of the direct current motor armature is usually very small, sometimes being only a fractional part of an ohm. This being the case, together with the fact that most direct current motors are operated on constant voltage circuits, would lead one to think that a very large current would be drawn from the line while the motors are operating. This is not altogether true, however. There are two reasons why a current flowing into a motor armature is restricted. In the first place a limiting device is inserted in the circuit between the supply line and the motor. More will be said about this feature later on. The second reason is that the motor itself possesses an inherent property of regulating the amount of current supplied to it. For instance, if the load is heavy and more current is required to carry it, the motor automatically adapts itself to these conditions. On the other hand, if the load is light the motor will draw but a comparatively small current from the mains. This current regulation in the armature of a direct current motor is due to what is termed—counter electro-motive force. It will be remembered that in another article of this series

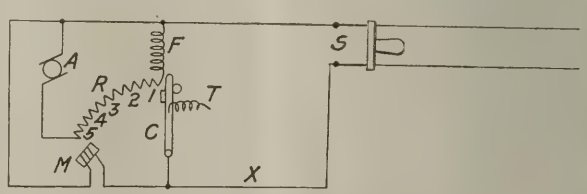


Fig. 5—Diagram of Starting Box and Connections With No Voltage Release

it was stated when a conductor cuts the lines of force of a magnetic field a current is generated in it, in other words, generator action is present. The same thing is true with the conductors of the motor armature. Even though the rotation of the armature is produced by the current flowing through its windings, these same conductors nevertheless cut the magnetic field from the pole pieces and tend to develop an e. m. f. in them which is opposite in direction from that of the supply line. In other words, even while the machine is operating as a motor it also possesses the function of a generator. This inherent property of the direct current motor is one of its most valuable assets.

It has been stated in other articles in connection with the direct current generators that the magnitude of the e. m. f. developed in a conductor cutting lines of force depended among other things upon the rate of cutting. The same thing is likewise true with the counter e. m. f. developed by a direct current motor. For example a certain direct current motor operating upon 110-volt circuit has no load attached to the pulleys. Under these conditions the current required for its operation is very small, being only sufficient to overcome the frictional losses of the machine. The ohmic resistance of the armature is very low, but the current taken from the line is almost negligible. This means that the counter e. m. f. developed by the revolving armature is almost equal to

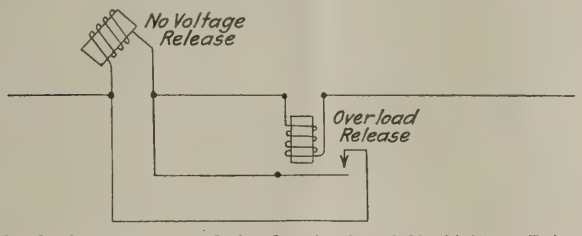


Fig. 6—Arrangement of the Overload and No Voltage Releases

the line e. m. f.. This may easily be proved by quickly disconnecting the machine from the supply mains and attaching the leads of a voltmeter to the terminals of the machine before the armature has lost its momentum.

Now, if a load be connected to the pulley of the motor there will be a tendency to slow it up. This tendency will be accompanied by a slight falling off in the counter e. m. f. which in turn will result in an increase of current in the armature. The amount of this increase will depend entirely upon the magnitude of the load connected to the pulley. Only sufficient current will be taken from the line to carry the load attached to the motor.

Means of Starting

While the counter e. m. f. developed in a revolving armature is sufficient to protect it from an excessive flow of current, some additional device is required when the motor is first connected to the supply line. It is evident that if the motor is carrying a load it will take an appreciable amount of time for it to come up to speed. Unless the armature is protected in some manner this length of time will be long enough to permit an excessive inrush of current which will certainly damage and perhaps destroy the entire armature winding. For this reason devices have been designed to use with motors of different types when they are first connected to the power supply. Large numbers of starting resistances or starting boxes as they are called have been designed, but in general they are similar to the one shown in Fig. 4. This, however, represents the simplest form or method of starting a direct current motor. When the main switch is closed it must be known that the variable resistance is in series with the motor armature. This variable resistance is then reduced step by step until the armature acquires its normal speed, at which time all of the resistance has been cut out of the circuit. It will be noted that the field windings receive the full voltage of the supply mains as soon as the main switch is closed. At first thought it might be considered that this arrangement would be all that would be required, but there are conditions that arise from time to time on any power circuit, which require starting apparatus that embodies other protective features. For example, if a motor is operated on a circuit which for some reason fails, the motor will, of course, stop, but unless some device is incorporated in the starting box which will insert the variable resistance again in series with the armature, there is nothing to protect the latter if the power again returns to the supply circuit, and under such conditions the armature of the motor would be destroyed. For this reason, therefore, the majority of starting boxes include what is known as the *no-voltage release* coil.

Fig. 5 shows diagrammatically the connections of a starting box which contains the no-voltage release. When the main switch, *S*, is closed no current is supplied to the motor until the contact arm, *C*, is moved to the first point on the resistance, *R*. As soon as this contact is closed the field windings are connected to the full voltage of the line and a small current flows through the resistance *R* and the armature, *A*. As the armature speeds up the contact arm is moved step by step until all of the resistance has been cut out of the circuit. The end of the arm will then rest upon the fifth point in the variable resistance and in this position it will be in contact with the no-voltage release magnet, *M*. It will be seen that this no-voltage magnet is in series with the line. The contact arm, *C*, is normally held on the point, *5*, on the variable resistance by the magnetism of the no-voltage release coil, while the motor is operating. Should any interruption occur on the supply line the no-voltage release coil will lose its magnetism and the contact arm will fly back to the off position by the tension of the spring, *T*. In this way the armature is thoroughly protected, for even though the power is again restored to the line the armature is no longer in the circuit, and in order to start the motor again the contact arm must be operated. It will be noted that while the contact arm is in the running position, or point *5*, of the variable resistance, that the entire resistance is in series with the field of the motor. This condition, however, does not in any way interfere with the proper operation of the motor

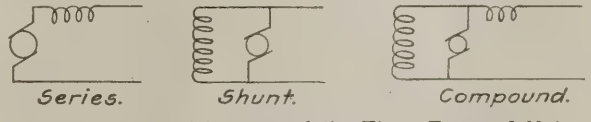


Fig. 7—Simplified Diagrams of the Three Types of Motors

since the variable resistance is comparatively small and has very little effect upon the current flowing through the field winding, which has a resistance of many ohms.

There is another point in the operation of direct current motors which is necessary to guard against and for this some provision should be made. There is danger of placing too heavy a load on the motor. If this is done the armature is not able to maintain its normal speed and as a result the counter e. m. f. drops to such an extent that an excessive flow of current through the armature winding takes place. If some scheme was not provided for the protection of the armature under these conditions, damage or destruction of the machine would be sure to follow. In most starting boxes, therefore, a device is included known as the *overload release*. The overload release, together with the no-voltage release, protects the motor against such failures as are liable to occur.

These two releases are usually connected so as to operate as indicated in Fig 6. The overload release magnet is inserted in series with the main circuit at the point, *X*, in Fig. 5. It will be seen that it carries the full load current of the motor. If this load current becomes too high for the safe operation of the motor the overload release magnet draws up its armature and closes a contact which shunts out the current from the no-voltage release coil. When this occurs the no-voltage release magnet loses its magnetism and no longer holds the contact arm in the running position, and the latter flies back and opens the circuit in exactly the same manner as if the power supply had been interrupted.

The methods given here for starting motors are the most simple ones and require the service of an attendant who is more or less experienced in handling a starting box. There are, however, other means of motor starting which are entirely automatic in their operation and which may be handled by an operator who is quite inexperienced. Such devices are rather complicated and a description of them would be out of place in this article.

Classification of Motors

In general there are three types of motors which are comparable in every respect to the three types of generators, namely, *series, shunt* and *compound*.

The series motor, as its name implies, has its field windings and armature windings, in series. The shunt motor has its field windings in parallel with the armature, and the compound motor, while possessing a shunt field, has in addition a series field. These three types are diagrammatically illustrated in Fig. 7. Each type has its particular use, a use for which it is much better adapted than either of the others.

The character of the work to be performed by any motor naturally falls into three classes: first, constant torque at variable speed; second, variable torque at constant speed and, third, variable torque at variable speed. An illustration of the first class of work is found in the operation of a motor in driving a hoist or an elevator. In this case it is evident that the load is constant and is to be moved at varying rates of speed. For this purpose a series wound motor operated from a constant voltage circuit is generally used. The series motor also finds application in street railway work. In this kind of operation the motor is required to develop a variable torque and a variable speed. In starting the car a high torque is required and the speed is a minimum, but as the car gains headway the torque decreases and the speed increases.

When a motor is chosen to drive line shafting in a machine shop it must necessarily run at constant speed regardless of the number of machines in operation or the work being performed by them. For this class of work the shunt motor is best adapted. In general the compound motor is used for work of the same character as the shunt machine with the possible exception that it is better suited to starting loads which require a high initial torque, but which after being started require a constant speed. The series field of the compound machine makes the high initial torque possible but does not in any way interfere with the constant speed of the machine at variable torques after the load has been started.

Speed Regulation

In most cases it is desirable to control the speed of a motor and this may be accomplished in a number of ways. The simplest method, although the one which is probably the least used because it is so inefficient, is that of inserting a resistance in series with the machine. While this method will control the speed of the machine it is obviously very wasteful of energy as much power is lost in heating up this added resistance. Street car motors are started by connecting their resistance in series with them but this resistance is cut out step by step until the motors receive the full voltage of the line. A shunt motor or a compound motor may have its speed regulated to a certain extent by introducing a resistance in series with the machine, but this is not the usual procedure. Whenever it is desired to regulate the speed of an armature in either a shunt or a compound machine some means is provided for increasing or decreasing the strength of the field. By weakening the field of either of these two types of motors the armature is speeded up, or by increasing the field strength the armature speed will be diminished. The reason for this is that the armature of either the shunt or compound machine strives to develop a counter e. m. f. equal to the e. m. f. of the line. This being the case it is obvious that if the strength of the field is increased the speed of the armature will not have to be as great in order to develop the required e. m. f. On the other hand if the strength of the field is diminished, the armature will necessarily have to revolve at a higher rate of speed in order to develop an e. m. f. of sufficient magnitude to prevent excessive current.

This variation in field strength is usually accomplished by inserting a variable resistance in series with the shunt field windings. Since the ohmic resistance of the windings, themselves, is considerable, the current which flows through these windings is relatively small and therefore the amount of energy consumed in an additional resistance in series with them is also comparatively small.

Another method for regulating the speed of a direct current motor, but one which is not so extensively used, is that of removing the armature from the magnetic field. One of the most successful motors of this type is so designed that the armature may be moved in the direction of the shaft and away from the magnetic field. This, of course, has the same effect as weakening the field so far as the counter e. m. f. is concerned, and the speed of the machine is controlled entirely by shifting the armature into a stronger or a weaker field as may be desired.

Another machine accomplishes variable speed by a design which permits the cores of the field poles to be moved toward or away from the armature. In all of these schemes the object is the same, namely, weakening or strengthening the magnetic field.

Conclusion

The present article on the subject of direct current motors will conclude the series which has been running for the past few months under the head of "Elements of Practical Electricity." It is hoped and believed that it has been of advantage and benefit to the men for whom it was written. The subject in itself is inexhaustible and, while the present article concludes this series, the educational purpose of articles of this nature will in no way be lost sight of and from time to time in the columns of the *Railway Electrical Engineer* other articles will be found that will be interesting, instructive and no doubt of much advantage to those who are interested in coupling some of the fundamental principles with their everyday practical experience in electrical work.

Systematic Care of Car Lighting Equipment

One Method of Handling Electrical Apparatus on Passenger Cars During Shopping Period

By M. F. Hand*

IN most passenger car shops it is usually the practice to place cars awaiting shopping in the yard commonly called the "storage," and the length of their stay depends upon the nature of repairs required, and the ability of the shops to handle the repairs in question; also upon the class of car.

Preliminary Inspection and Repairs

The length of time that a car may remain in the storage may extend over quite a period, and it is essential in order that the battery equipment may receive proper attention that systematic and regular inspection be made. I have, therefore, found it good practice to have a daily inspection made of cars arriving for shop attention, assigning to this work a man who is thoroughly familiar with the various types of equipment, one who is capable of "shooting" trouble and making all classes of repairs.

At this time each new arrival is carefully inspected and a report showing the date of arrival, condition of equipment, and any unusual repairs that may be necessary is made out. A notation is also made upon this report as to whether or not the car demands immediate attention.

By referring to this report the foreman can tell how long the car has been in the yard and how soon the batteries should be charged, which is very important, since we know that with electric batteries it is not good practice to let them stand longer than 30 days without charge if sulphation and disintegration are to be prevented.

Most storage yards have no charging facilities, as the expense of such an installation would not justify its utility, and it is therefore necessary to have the car switched to a point where charging lines are available. This, however, can often be avoided if, a few days in advance, the attention of the general car foreman is called to the matter, as arrangements may then be made to have the car shopped.

Care of Batteries and Interior Equipment

When the car is shopped, orders for special work desired are issued to the proper men having these repairs in charge and also to the car department foreman.

Lamps and shades are removed from the car at once as well as the batteries. The fixtures, with the exception of those in buffet, dining and business cars, are left intact where they are enameled by the painters to match the interior finish of the cars. In most cases it is necessary to re-enamel these fixtures about once every four years.

The battery is transferred to the battery shop, where it is placed on the charging table and connected to the circuit after inspection has been made to see that the plates in all of the jars are covered with at least ½ in. of electrolyte. The battery is then placed on discharge for a few minutes, while the gravity of the pilot cell and voltage readings of all of the cells are being taken and recorded. The charge is then begun and continued at normal rate until the cells are gassing freely.

The battery record supplied by the office is checked with data on the record plate on the tray, and if the battery is recorded due for washing, a cell is inspected to determine the depth of the mud in the jar and the condition of the separators and plates. If this condition is such as to warrant eight or ten months' service, the battery is discharged at the normal rate after recording the gravity at the pilot cell. Hourly voltage readings of individual cells are taken usually for five or six hours, after which the readings are taken at half-hour intervals until an e. m. f. of 1.7 per cell is reached, when the gravity of the pilot cell is again recorded and the charge resumed. If the discharge was not satisfactory, or "sick" cells appeared, the battery is washed or given necessary attention to put it in serviceable condition.

Wherever a defective cell is found it is carefully inspected and proper repairs made, and if necessary to replace a group a secondhand one is selected that has apparently about the same life as the remainder of the cells, as it has been satisfactorily proved that cells of very great difference in age do not work quite as efficiently as those of the same age.

After all cells are worked up to practically the same condition and all trays, connectors, covers, etc., are cleaned and in good condition, a final charge is given to the battery, after which the electrolyte is added about 1½ in. above the plate and the specific gravity is adjusted to from 1.215 to 1.225. If the battery has been washed, this information is shown on the record plate on each tray, and if only inspected, a record is made of the fact on the lead plate, showing the probable length of time before washing will be necessary. This latter plate is applied to the front of the pilot cell tray.

Care is exercised to see that a battery which probably will not run without washing until the next shopping period, is placed in a main line car or one coming into a terminal properly equipped for battery washing; all branch line cars being provided with batteries good for two years' service.

We are finding that ordinarily our batteries will run three years with constant current devices, and five or six years with constant potential devices, without washing, with the exception perhaps of some of our heavy duty diners and sleepers. Inspection of one or two cells is made, however, when the battery has seen two years' service since having been washed, in order to detect any abnormal conditions that may arise.

With our constant current equipment the life of our positive group averages about five years, and with constant potential devices, some of which we have had in service some five years, I would hazard a guess that ten years' life will be the average, as the plates appear at just about their best now.

*Foreman, Car Lighting Dept., A. T. & S. F. Ry., Topeka, Kan.

Our experience has also proved that the mercury compound jar and the heavy ribbed wood separator are best adapted to our service. All batteries leave the shop with connectors "burned" to the lugs by the use of the carbon arc, which does away with bolt connections that have always proved a source of more or less trouble.

Care of Generators

When the trucks are removed from under the car, the generator is completely dismantled, each part being thoroughly cleaned; insulation of fields, etc., carefully checked; the inside of the generator painted and all parts put in first class condition before being assembled. Tests for grounds are made both before dismantling and after assembling. The commutator is turned down if necessary, and where sleeve bearings are used shafts are checked for wear, 0.020 in. being considered the limit. Ball bearings are thoroughly cleaned and regreased and a dated tag applied indicating these bearings should again be greased six months later. Brushes are cleaned and properly fitted to their holders and the periphery of the commutator is smoothed and cleaned. All connections are carefully examined and put in first class condition. All worn or defective parts are renewed and repaired and special attention is paid to pole changers, switches and brush rigs. All suspension parts are renewed when necessary, particular attention being given to bolts and main bearing pins. Axle pulleys are applied so that they will represent a perfect circle as near as possible, the shimming being so distributed that there will not be more than from 3/16 in. to ⅜ in. between the halves when the pulleys are tight. Both axle and generator pulleys are crowned ⅛ in.

The level of the generator is maintained so that the centers of the armature shaft are the same distance from the rail and a belt clearance of 1 in. over the end sill and 1½ in. over the brake beam is considered as minimum.

Special care is taken to see that leads from the generator to the car body are in good condition and properly marked; that they are so arranged that the weight strain is equally distributed to each of the leads, and that the leads clear the rails at least 5 in.

Care of Interior Equipment

The regulators are carefully gone over to see that carbons are in good shape; that the automatic switch is properly adjusted; that moving parts are checked for wear and that all connections are properly tightened. Dash pots are inspected, cleaned and new glycerine applied where necessary. The current adjustments on constant current devices are left to the inspector under whom the cars are assigned for service. Switch panels are carefully gone over, the switches tested and all circuits checked to see that they are properly fused.

Fans are thoroughly cleaned and oiled and put in first class repair, and where they are equipped with ball bearings the date of cleaning and oiling is recorded in the regulator locker for the information of the inspectors. Once each year is considered sufficient for this attention.

Final Inspection and Report

When the car is ready for trimming, the lamps, shades, etc., are applied, the generator motored and the final inspection given, which consists in testing out of the various parts of the equipment, checking lamps, fixtures, etc., and seeing that all circuits are free from grounds.

Each man working on the equipment reports in detail to the foreman the nature and amount of work done and materials used, also materials that for any reason may have been removed, which if suitable for further use are properly credited to the car.

A report in full of all cars leaving the shop during the current month is made monthly to the main office or head of the department.

American Soldiers Released from Rastatt Prison Camp on Their Arrival at Basle, December 7

ELECTRICAL ENGINEERS DISCUSS WELDING

At the first meeting of the American Institute of Electrical Engineers at their recent mid-winter convention held at the Engineering Societies building, New York, in February, the subject of welding received attention to the exclusion of all other matters. So great is the present interest in welding in engineering circles that this first gathering of the convention was arranged to be a joint meeting of the American Institute of Electrical Engineers and the members of the American Institute of Mining Engineers, whose convention was concluded on the day the meeting was held.

The five papers presented gave abundant evidence that a vast amount of time and thought has been given to the study of the many problems involved in making welds electrically. Much of the matter presented was of a highly theoretical nature, but the fact cannot be overlooked that it is by exhaustive research along theoretical lines that any art or science advances to a sound and practical application.

Of particular interest were the numerous lantern slides shown by S. W. Miller. These screen illustrations showed very plainly the peculiarities of different welds as examined under the microscope. The inclusion of many impurities such as pearlite, cementite and nitride of iron and others whose exact nature is unknown, were quite visible. The grain boundaries and oxide films which surround the globules of the metal could be distinctly seen, as well as the effect of stress upon these grain boundaries and oxide films, the effect being, in almost every case, to start a rupture of the weld along these lines. In general it may be said that while many welds have been subjected to examination and much has been learned concerning their microscopic structure, there is still a great deal to be learned in this direction before a welding method can be devised which will produce a weld of 100 per cent strength on every occasion.

The present stage of the welding art was significantly stated by Commander S. V. Goodall of the Royal Navy. In Commander Goodall's opinion, the correct method of approaching the problem of electric welding is first to obtain workmen who are thoroughly trained and skilled, and that only certified men should be employed in this work. The dominating factor in welding is the lack of uniformity in the weld and the corresponding uncertainty as to whether the weld is good or bad. Substantially the same conclusion was drawn by H. A. Horner of the Emergency Fleet Corporation later in the discussion when he said that good arc welders must be able to concentrate their minds upon their work. In Mr. Horner's opinion the haphazard selection of arc welders can result in nothing but poor and inefficient work and that it is a conservative estimate to say that the personal equation of the welding operator is 90 per cent of a good weld.

On the other hand, with expert welders good work can be repeated again and again and welds have been made having a tensile strength as high as 75,000 lb. per sq. in. Moreover, test strips subjected to strain not infrequently break outside the weld.

A number of practical welding features were described and illustrated with slides by O. H. Eschholz, whe presented a paper treating of the fusion of arc welding. Mr. Eschholz spoke of the advantage derived from the use of a short arc, stating that in his experience he had found that the best weld characteristics were obtained with an arc not longer than ⅛ in. and preferably about 1/16 in. The importance of using the correct welding current with respect to the kind of work, in order to secure the best degree of penetration was also emphasized.

Another instructive paper was presented by H. M. Hobart, chairman of the Welding Research Sub-Committee of the Emergency Fleet Corporation. Mr. Hobart's paper was a general summary of applications of practical welding and contained much of interest regarding what has been accomplished with the various welding methods.

The conclusion that may be drawn concerning the future applications of electric welding is that some means must be devised whereby the quality of a welded joint can be determined with certainty. The future will unquestionably add to our present knowledge of the subject and it is altogether reasonable to prophesy that subsequently we shall be able to determine accurately the strength of any weld. Until such time arrives the safe line of procedure to follow is that of training men of suitable qualifications to become expert welders. If important welding is entrusted to men who have proved their ability there is little danger that serious failures will result from careless workmanship.

ELECTRIC LIGHTING OF STEAM RAILWAY CARS*

The electric lighting of passenger cars on steam roads has made it possible to add a number of conveniences for the benefit of the traveling public. In addition to the efficient lighting service it is possible to provide fans, pressing irons and devices for heating water. Light can be furnished at almost any place in the cars. For instance, Pullman cars are equipped with reading lights at each seat and for use in the berth when the occupant retires at night. Lights have also been placed under the seats in Pullman cars, which eliminate the necessity of burning the deck light when the berths are made up and the passengers who occupy the upper berths are relieved of the annoyance of such lights glaring in upon them. The application of lights and devices such as mentioned above are not adapted to the old gas lighting system.

Many improvements have been made on the electrical equipment for car lighting service within the past few years. One of the foremost improvements from a maintenance point of view is the application of ball bearings in place of brass bearings. The brass bearings are oiled either by a ring which travels on the armature shaft and through oil in the bottom of the bearing heads or by means of wool waste which is saturated with oil and pressed against the shaft through an opening in the bearing. With both methods of lubrication it is necessary to supply oil about every thousand miles. The oil works out between the shaft and bearings into the interior of the generator, causing it to become gummy and dirty. The brush holders, field and armature insulation become saturated with oil, which may cause grounds, and ultimately trouble develops in the lighting system. Some difficulty has been experienced with the brass bearings

*Abstract of a paper by B. H. Ehringer, foreman of electricians on the New York Central at Root street passenger car yard, Chicago. Presented at recent meeting of Car Foremen's Association of Chicago.

running hot, in many cases permitting the armature to drop down on to the pole pieces which usually results in damage to the armature and field coils, necessitating the renewal of parts. This resulting damage may cost between two and three hundred dollars. With the use of ball bearings nearly all this trouble has been overcome. It is only necessary to supply grease to the ball bearings once every six months. Hard grease, such as is used with ball bearings, does not work into the generator like oil does, and very little trouble has been experienced on the New York Central with the ball bearings running hot.

Many roads at the present time are investigating methods of suspending generators from the cars and are comparing the truck-hung and body-hung equipments to see which is best suited to their requirements. I took part in a test made on the New York Central between Cleveland, Ohio, and Toledo. A baggage car was equipped with a one kw. Gould generator suspended from the body of the car by means of the New York Central's standard body-hung suspension. The object of the test was to determine the actual operating conditions of the generator, suspension, belt, pulleys and trucks. In order to carry on the test intelligently the flooring in the car was cut away over the generator and the axle pulley and an observation box was built under the car with glass on two sides which permitted the observer to get a clear view of the actual service conditions. I noted the following conditions during that test: there was very little jar or vibration on the generator and the suspension; there was apparently no wear to the suspension parts, and very little, if any, loosening up of bolts; and the danger of the suspension parts breaking appeared to be slight. The generator operated under almost perfect conditions, as there was very little jar or vibration, which usually is hard on bearings, shafts and connections. At times the belt vibrated or flapped enough to strike the brake beam, so it was recommended that more brake beam clearance should be arranged for on body-hung equipment. After my experience in the observation box of the test car I fully realized there was *some* pounding on a truck.

Since body-hung equipments have been operated into the New York Central yards at Chicago only two cars have shown any great amount of wear on the suspension parts. Both of these cars arrived with about 8 in. broken off of the armature pulleys. The flanges of these pulleys were 2½ in. high and ⅝ in. thick at the face of the pulleys tapering to ⅜ in. at the outside edge. With a piece, the size indicated, broken out of the pulleys they were thrown out of balance, which caused the generators to shake and pound, resulting in considerable wear to the suspension parts.

I believe there is a fine opportunity for a committee to develop something on standardization of car lighting equipment. The New York Central, for instance, has five different makes of equipment and eleven different types. However, type "D" Consolidated equipments are being disposed of as rapidly as possible. Eliminating that type still leaves four different makes and ten different types. It is therefore easy to understand the need of the large number and variety of repair parts in order to maintain so many different types of lighting equipment.

Every electrical department has its own system of inspecting for car lighting equipment, yet trainmen and carmen often ask the question, what should they do in case of trouble with the lights. The answer is not so easy, since it depends largely upon the nature of the trouble and all the details concerned with it. In most cases there are really only a few failures in car lighting service that should be taken care of by train crews, such as belts applied or tightened, fuses replaced, lamps replaced and suspension parts inspected and tightened. If other repairs are required they should be made by an electrical repairman who is trained and skilled in axle lighting work and who has the proper tools and instruments with which to make tests. Inexperienced persons attempting to make repairs or adjustments are liable to seriously damage the equipment.

The New York Central recently issued a book of instructions for the maintenance of electric car lighting equipment. This book is intended primarily as a guide to electricians and other employees directly or indirectly connected with the maintenance of electric car lighting equipment. It is not a text book, but contains instructions as to approved methods and practices in caring for such equipment. A copy of this book has been given to each electrician and others interested and it will be of assistance in raising the efficiency of the car lighting service.

* * * * * *

The above paper was read to the Car Foremen's Association of Chicago at its monthly meeting held on February 10, at Hotel Morrison, Chicago. B. H. Ehringer, electrical foreman on the New York Central, at the Root Street passenger car yards, Chicago, presented the paper following a supper which was attended by about 150 members of the Car Foremen's Association. It was the opinion of the meeting that the paper was the first of its kind ever presented to that association.

In the discussion which followed the reading of the paper the car lighting men's viewpoint was well presented in the remarks of W. E. Buckmaster, chief electrician of the Baltimore & Ohio, Chicago Terminal, who said in part: "I am pleased to find that this subject has been brought up for discussion because little recognition has been given it by car department men. Electric lights on passenger cars have become a necessity instead of an experiment or a luxury. In view of this there should be closer co-operation between electrical and car department men. The electrical departments have had rather a hard battle on their hands to gain recognition from the car men as to the importance of electrical work. One of the greatest troubles we have had has been to get the proper clearance for axle pulleys, belts and suspensions. Axles should be provided upon which the driving pulleys for car lighting generators can be fastened properly. Those who are not familiar with axle generator equipment are not in a position to realize the importance that the proper fastening of the pulley has to do with the successful operation of the equipment.

About five years ago it was my good fortune to observe the action of axle equipments in operation while riding in and out of Chicago on suburban trains. The suburban traffic paralleled tracks for through service upon which nearly every car had axle equipment and I had the opportunity of watching the actual operation of the car lighting equipment on cars running on the through service tracks. I observed that

some of the generators were swinging back and forth on their suspensions, indicating eccentric pulleys on the car axles, while on other equipments the belt flopped considerably, striking the end sill and brake rigging.

Some of the roads have begun to realize the importance of turned axles and furnish them for all passenger cars. Others specify turned axles for every four or five furnished. These are used for mounting the axle pulley under the truck next to the generator. The smooth forged axle does not give the results that are obtained from a turned axle. With the turned axle we are able to fix a standard bore for the axle pulley bushing which assists greatly in applying the axle pulley properly and quickly. Of course, if there is the slightest inequality in the axle pulley there is liable to be a flopping of the belt. This is especially true of the under frame equipment. Recently a car came into the Chicago terminal which had been losing a number of belts. On account of the time being short for the car to remain in the terminal we were not able to change the axle pulley, which was the primary cause of the trouble as the pulley face had been dented and was therefore not true. We found, however, that the car was low on this end and that above the belt a ⅜-in. bolt projected through the fish belly about 5-in. and about 24-in. from the axle pulley. This belt was coupled with a Walker fastener which caused the end of the belt to project out about 1¼-in. at right angles to the outside face of the belt. The defective axle pulley had caused this belt to flop so that the fastener struck the bolt. In order to correct the trouble we changed the bolt so that its head was under the girder and its extension above. In this way the working of the generator was taken care of temporarily and when the car returned we changed the pulley.

With reference to ball bearings, I have had two cases within the last two years that have acted as clinching arguments in favor of ball bearings. One of these cases was the arrival at the Chicago terminal of a car that had traveled 1000 miles with an armature shaft broken inside the pulley and head. If this had been a sleeve bearing we would have lost the belt, armature pulley and shaft, besides damaging the pulley end head and bearing to the extent that it would have had to be scrapped. However, we were able to use the same belt, pulley, heads and all except the broken shaft. Within the last two months I have had another case of the same kind on another make of equipment.

In concluding, I again want to call attention to the necessity of co-operation between the carmen and the electrical forces in matters pertaining to the transmission, from the axle pulley to the generator. We are able to take care of the generator, batteries, fixtures, etc., but in the transmission system we must have your help.

To the Lady of New York Harbor certain recent events must prove puzzling. The fact that the outgoing George Washington one day and the incoming Leviathan another are both peace ships by right of the passengers they carry is not apparent; there is distinction between winning and making peace.

LOST—ONE CAR LIGHTING CLUB

Aside from the facts that the battery house was locked and dark, that the officers were absent and that the apparatus and demonstrator were not on the job the special meeting of the New York Car Lighting Club staged for Tuesday evening, March 4, at which time the mysteries of the Gould equipment were to have been expounded, was a perfect success.

Notwithstanding the lack of these minor details, a very fair showing of the "faithful" were on hand at the appointed time and place. Some of them came quite a long ways, too, so eager were they to pick up any stray crumbs of information that might drift out in their general direction.

They weren't quitters either, for they stuck around among the battery crates until the old clock in the Lackawanna depot pointed to 9:30. By that time the majority began to harbor a sneaking suspicion that something had gone wrong in spite of the evidence they possessed to the contrary in the shape of a postal card. Finally, when it was apparent that the

Among those disappointed were Robert Bowman, H. Capell, James Wright, Joseph A. Chingos, J. W. Bellman, Edward H. Deane, F. A. Hodges, Harold Jaquiss, E. C. Meilloret, E. T. Tournie, John Weis, J. H. Ferrier and D. Finn.

officers of the club had either been killed in action or taken prisoners it was regularly moved and seconded that the meeting adjourn. Just before this final action was taken, however, the idea occurred to the representatives of the *Railway Electrical Engineer* that it would be a good plan to preserve a record of the faithful in the archives of the association, and, with this thought in mind, their photographs were taken.

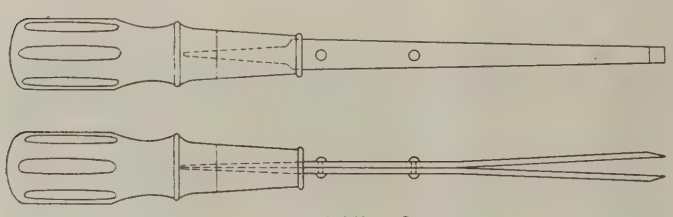
Later information from the front line trenches advises that the officers were not dead, but were simply sleeping and that the apparatus, so essential to the demonstration had been located in the wilds of Secaucus, N. J. We earnestly hope that whoever admits the responsibility for sending so many on a wild goose chase may be able to fortify himself with plenty of excuses before meeting any of the goose chasers.

Just as we go to press we are advised that another attempt will be made to hold the meeting on March 12, at the same hour and place.

PRACTICAL STUNTS

A Handy Screw Driver

A very useful and handy screw driver may be made for holding and turning small screws into tapped holes which are almost inaccessible. The tool shown in the illustration can be made easily from an ordinary screw driver handle and two pieces of spring steel, which should be machined into the shape shown and then riveted together at two points near the handle. To use this screw driver, the spring ends should be pressed together and inserted into the slot cut in the screw. The screw driver will then hold the screw after the pressure has been released from the spring.

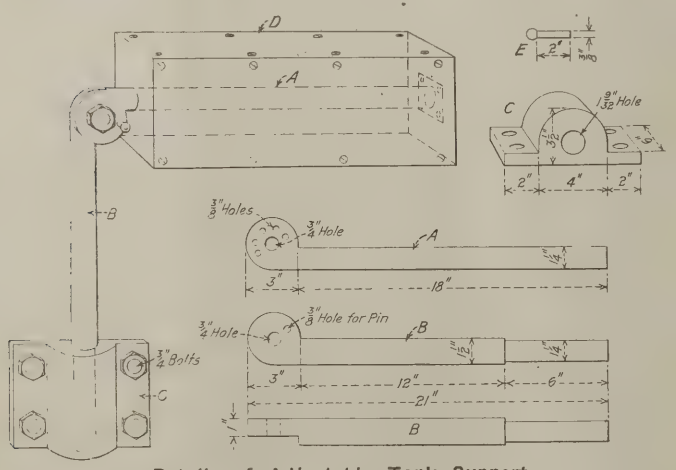


A Tool for Holding Screws

A Handy Device For Repairing Lead Battery Tank

By Carl E. Schwanz

A convenient method for holding lead battery tanks while they are being repaired is illustrated in the following sketches. The arrangement consists of two 1¼-in. iron rods *A* and *B*, of the dimensions shown, a supporting socket *C* and a block of wood *D*, which fits inside the battery tank while the latter is being repaired. The two 1¼-in. rods are flat at one end, the flat portion of one of them being drilled with a number of holes arranged in a semi-circular manner above a larger hole through which a pin is passed to fasten the two rods together. In the second rod *B*, a single hole is drilled in the flat portion and by passing a pin through this hole it will engage in any one of the holes in the rod *A*, and thus the angle may be adjusted to suit the worker. The lower end of the rod *B* is turned down with a shoulder so as to fit in and swing free in the socket, as shown. The block of wood which is covered with a ⅛-in. steel plate is drilled to fit closely upon the rod *A*. The block is free to move around the rod, and by swinging the rod from the bracket and adjusting the pin at the joint, a battery tank can be placed in almost any position to facilitate repairs.



Details of Adjustable Tank Support

Gripping Pipe or Conduit with an Ordinary Wrench

E. T. Paul

Four different methods of improvising wrenches for gripping pipe or conduit are shown in the illustration. It is seldom that emergency conditions will be such that a man cannot arrange a wrench in accordance with one of the methods illustrated.

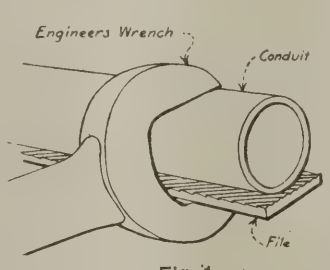


Fig. 1

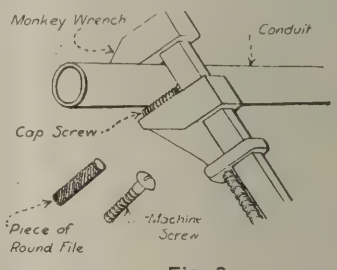


Fig. 2

Fig. 1—With Flat File
Fig. 2—With Vertical Round File or Screw

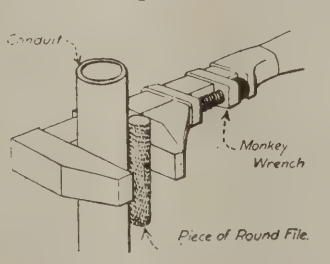


Fig. 3

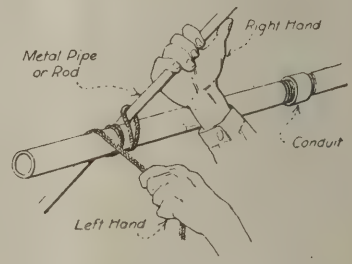


Fig. 4

Fig. 3—With Horizontal Round File
Fig. 4—With Rope or Cord

With the flat file method in Fig. 1. the opening between the jaws of the wrench should be somewhat larger than the diameter of the tube to be handled. Then a piece of flat

file is placed between the conduit and the jaw and wedged up against the conduit, if necessary. The teeth in the file will grip the tube firmly, if adjustments have been properly made.

In Fig. 2. is shown another method wherein either a cap screw, a machine screw or a short piece of round file can be used in combination with the monkey wrench to grip the conduit. A square-headed cap screw is better than either the machine screw or the file, because the two latter members tend to roll out of the jaws of the wrench. This method is used to best advantage with conduits of diameters less than three-quarters of an inch.

In Fig. 3. a piece of round file and a monkey wrench are employed. In using this scheme the jaws of the wrench are first opened just wide enough to admit the conduit, then the short piece of round file is inserted as indicated. If the handle of the wrench is pulled—toward the reader in the sketch shown—the file rolls into position and wedges and binds the conduit quite firmly. Reversing the pressure on the wrench handle will instantly release the file.

In Fig. 4. is depicted a method of turning a piece of conduit with a cord and a piece of metal pipe or rod. The illustration itself is self-explanatory. In some cases a piece of heavy copper wire or soft iron wire can be wrapped around the conduit about as indicated and thereby made to perform the function shown for the rope or cord in the picture.

Recalibration of Switchboard Ammeters

By L. L. Richart.

Due to an increase of load it sometimes becomes necessary to change the current transformer used for measuring power, controlling both main and feeder circuits. The change usually consists of substituting current transformers with larger ampere capacity in their primaries while the standard five-ampere secondary capacity is retained, thus changing the ratio of transformation to a larger value.

This increase of ratio does not interfere with the use of the same measuring apparatus providing certain minor changes are made. The integrating wattmeter and maximum demand meter only require a correspondingly higher constant in determining correct results. The same method applied to the ammeter would not be desirable, although correct. The ammeter can be very easily altered to read correctly with little or no expense by the method here given.

Two current transformers with 800-ampere to 5-ampere ratio were replaced by two transformers with a ratio of 1,500 amperes to 5 amperes, thus changing the ratio from 160 to 1, to 300 to 1.

The sketch indicates a 110-volt source of power of the same frequency as the circuit on which the current transformers are to be used, connected to the knife switch *S*, a slid wire rheostat, *R*, of 5 amperes capacity and 20 or 25 ohms resistance is connected with five lamp receptacles in parallel, completing the circuit in series to a 5-ampere A. C. ammeter, *A*, and the switchboard ammeter, *AX*, which is to be recalibrated. The tained in the ammeter *A*. The amemter *AX* then read knife switch *S* closed; the lamps *L* and rheostat *R* were adjusted until a current of five amperes was obtained in the ammeter *A*. The ammeter *AX* then read 800. The resistance was adjusted until meter *A* read 4.8 amperes. A pencil mark on the cardboard scale of the meter *AX* was made corresponding with the position of the needle. Again adjusting the resistance until meter *A* read 4.6 amperes the new location of the needle was marked on the scale of *AX*. This operation was continued making small reductions of current and retaining a record of each reading of meter *A*. The readings of meter *A* multiplied by 300 give

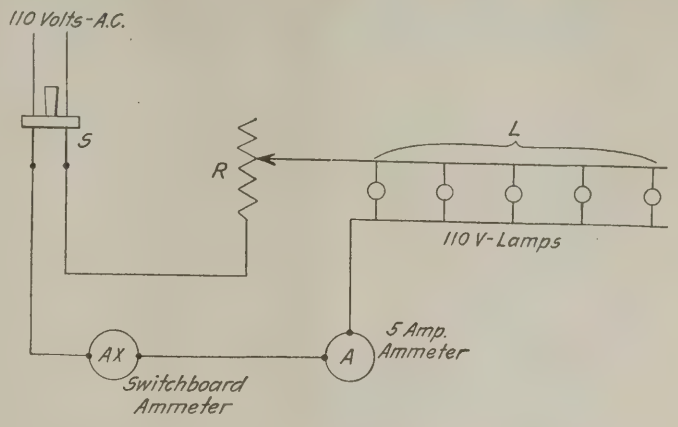


Diagram of Connections for Recalibrating the Switchboard Ammeter

current values corresponding to the pencil marks on the scale of the meter *AX*.

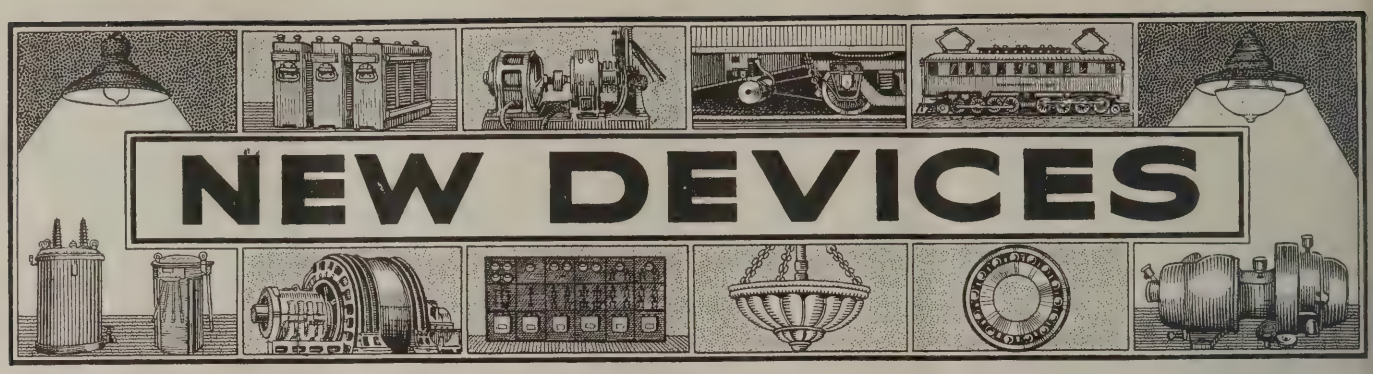
A new scale reading from zero to 1,500 amperes can readily be made on white cardboard by transferring the pencil marks from the scale of meter *AX* and affixing the corresponding current values.

It is apparent that the accuracy of this method depends upon the number of points located and the care exercised in marking the various positions of the meter. Ordinarily thirty values should prove sufficient.

Resistance of a Car Lighting Storage Battery

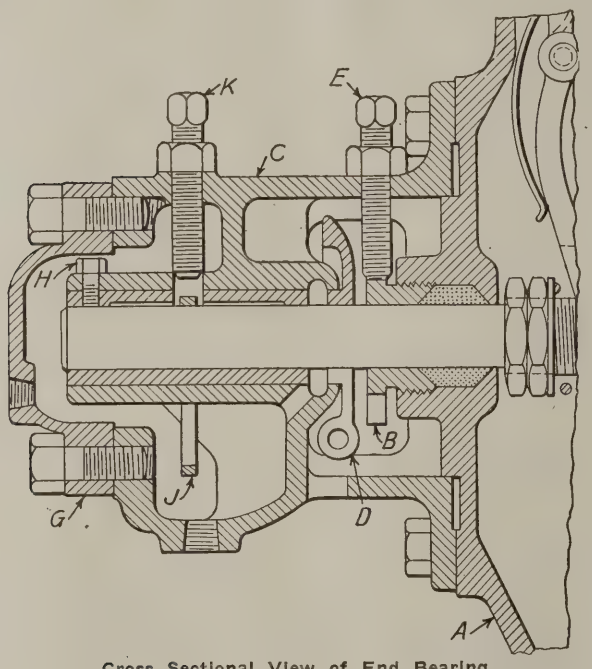
By K. C. Graham

The resistance of a battery may be determined as follows: Connect an ammeter in the light circuit and turn on enough lamps to draw about twenty amperes; connect a voltmeter across the battery circuit and note the deflection. With the voltmeter still connected, pull the light switch and note the instantaneous rise in voltage, as shown by the voltmeter. This increase in voltage divided by the ammeter reading obtained previous to opening the lamp circuit, will give the ohmic resistance of the battery. As an example, suppose the ammeter gives a reading of twenty amperes and the voltmeter a reading of thirty volts. Upon pulling the light switch the voltage increases to thirty-two, this being an increase of two volts over the reading obtained with the lamp load connected. Dividing two volts by twenty amperes we obtain one-tenth ohm, which is the resistance of the battery. The result thus obtained includes the resistance of the wires leading from the battery to the switchboard, but as these wires are usually of ample size and short length their resistance may be neglected.



New End Bearing for Buda-Ross Headlights

The admission of steam to the bearings of headlight turbines has been found objectionable, and to overcome this difficulty the Buda Company, Chicago, has recently developed and patented a new type of end bearing which is now being applied to the Buda-Ross electric headlight generators. The construction of this bearing is clearly shown in the illustration. The turbine cap, *A*, contains a stuffing box and packing nut, *B*, for packing around the shaft. The packing is inserted while the oil box, *C*, is removed and tightened just enough to set it up to the



Cross Sectional View of End Bearing

shaft. The oil box is then placed over the shaft and bolted to the cap, the deflector, *D*, first being placed on the shaft. After the oil box is bolted in place, the deflector should be located so as to clear the box and clamped in place by the setscrew which is placed in the deflector for that purpose. The setscrew, *E*, should be screwed down until the end is in one of the notches in the packing nut and should then be locked. This screw should be inserted far enough to prevent rotation of the packing nut, but should not clamp the nut on the shaft.

In order to apply the new bearing, the oil box, *C*, should be removed and the cover, *G*, and the setscrew, *H*, taken off. By loosening the lock screw, *E*, the oil ring can be removed, the bearing can be forced out of the oil box and another substituted. When inserting a new bearing, care should be taken to see that the set-screw, *H*, enters the hole in the bearing instead of being tightened down on the outside. The oil ring, *J*, should be replaced in the slot and the lock screw, *K*, tightened down to prevent the oil ring from jumping out of the slot.

The oil box has a capacity of four ounces. Oil is introduced through a small cup on the side of the box, the top of the cup being at the level at which the oil should be carried. Provision is made that in case the oil cup is broken off a sufficient amount of oil is still held in the box for proper lubrication. This bearing can be applied to all old Buda-Ross equipments with slight changes. Any high-grade lubricating oil can be used in this box, provided it is not so heavy that it prevents the oil ring from revolving on the shaft. These bearings have been run for four months with the original oil in the wells and have had enough left to run for a considerably longer period.

A New Locomotive Switch

A new locomotive switch of compact and rugged construction has been placed on the market by the Central Electric Company, Chicago. All current carrying parts are mounted on a slate base which is fastened into the switch casing as shown in the illustration. The switch-operating handle is attached at its extreme end to the cover of the conduit fitting and has a cast lug or finger

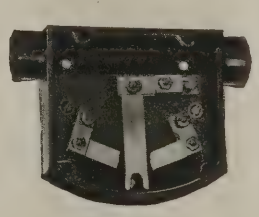


Fig. 1

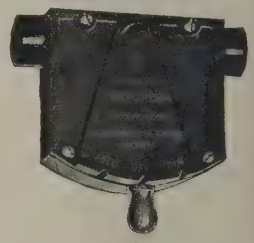


Fig. 2

Fig. 1—Locomotive Switch With Cover Plate Removed
Fig. 2—Same Switch with Cover Replaced and Handle Attached

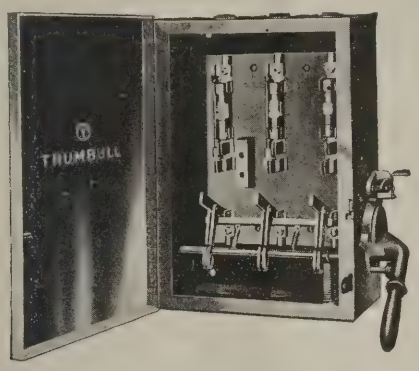
arm when the cover is in place. The switch handle itself near the handle whch fits into a U slot on the contact carries no current, consequently the possibility of grounds due to that source is eliminated. The action of the switch is positive and when thrown into any one of the positions full, off or dim, the handle is held in that position by means of a ratchet. The separate handle as described above eliminates the possibility of the electrical contact being thrown out of line due to anything hanging on or hitting against the switch handle. The switch has ample

current-carrying capacity and all loose connections and other troubles common to standard knife blade type switches have been eliminated. The size of this device is 6 in. wide across the top including the conduit lugs and is 7 in. from the top to the lower end of the switch handle. The switch lugs are threaded for ¾ in. conduit.

New Trumbull Safety Switches

To an already extensive line of enclosed safety switches the Trumbull Electrical Manufacturing Co., Plainville, Conn., has recently added some new types and sizes, as follows: Fuseless switches, single and double throw, 250, 500 and 600 volts; fusible switches, double throw; 400 and 600-ampere switches of one, two, three and four-pole types; "straight through" motor-starting switches with under-voltage release coil; motor-reversing switches.

These new switches, the company states, like those already included in its line of "Circle T" safety switches, are not merely enclosed switches externally operated but designed primarily for their ruggedness and safety features. The box cannot be opened until the switch is in "off" position. A catch prevents the switch from being closed while the box is open; however, if necessary to close the switch during inspection, it may be manipulated while the box is open, but this can be done only by an experienced man. To the ordinary user the blades and fuses are always dead whenever the switch is exposed, thus eliminating fire and shock hazards from exposed live parts. In the construction of these safety switches the company uses its type A knife switches, which for many years have been recognized as of highest standard knife-switch construction.



Motor-Starting Safety Switch of Straight-Through Type and No-voltage Release Coil.

In designing these switches the thought was not merely to put a box about a switch and arrange the latter to be operated outside of the box, but first build a very sturdy knife switch that can withstand the extra hard usage it will be subjected to when enclosed in a box that prevents seeing how the switch is operating, and then arrange for the enclosing and external operating mechanism so that the latter will function properly in all cases. It is felt that the purchaser is not primarily buying a box containing a switch, but rather a switch built to render the hardest service in the hands of an unskilled and not electrically informed operator, who must be protected from all hazards. The company's aim has been to make safety switches that will be looked upon, like its type A knife switches, as a standard guarantee of electrical and mechanical strength in switch construction. Possessing unusual endurance and the safety enclosure and operation, the company states that the slight additional first cost is neglible in making the switch installation safe for person and property.

A New Portable Electric Light

The Ru-lite is the name of a new portable electric light outfit which has recently been placed on the market by H. O. Rugh of 9 South Clinton street, Chicago. Some form of portable light is almost a necessity in certain branches of railway service, especially for emergency uses. Devices of this character assist inspectors, maintainers and others employed in hunting and repairing trouble at night, in dark places. The Ru-lite consists of a 50-ampere-hour storage battery and a spot light with a focusing device, which allows the user to adjust the light to cover a broad area or confine the rays to a slender beam, which is claimed will penetrate many times the distance of the ordinary spotlight. The source of light is a 30-candle-power nitrogen lamp, which, when burning, consumes 2½ amperes of current at 6 volts. The outfit is housed in a 3-ply hardwood case.

The Light Ready for Use

The case is provided with a means for mounting the lamp so it can be held rigidly in any position or deflected at any angle at the will of the user. There is also an automatic take-up reel with 10 ft. of flexible conducting cord permanently attached to the case, which allows the lamp to be detached from the base and carried to any local point for inspection purposes. An additional lamp with a handle and 20 ft. of flexible cord is contained in the case. Both lamps can be used at the same time if desired. The battery has a capacity of 20 hours' service and weighs 36 lbs.

General News Section

THE THIRTEENTH ENGINEERS, a railway regiment, organized in Chicago early in 1917, is expected to move from its present headquarters at Fleury-Fur-Aire preparatory to sailing for home at the end of the month. This was one of the first American units to reach France. The regiment operated a military railroad behind Verdun.

A NUMBER OF THE RAILROAD UNITS OF THE ARMY in France have been assigned for early return to the United States, according to an announcement issued by the War Department. The list of organizations assigned to early convoy includes companies 20, 60, 81, 82, 92, 93, 94, 95, 96, 98, 102, 104, 106, 107, 108, 115, 129, and 137 and casual companies No. 5 and No. 9, of the Transportation Corps, also the Twelfth Engineers' regiment.

A NEWS ITEM FROM WEST VIRGINIA states that Gibbs & Hill, the contractors for the electrification of the Norfolk & Western, have been awarded the contract for the electrification of the Virginian, in the Winding Gulf district. The extension of the electrification work on the Pocahontas division from Vivian to Farm is about completed and will be in operation within a short time. It is understood that a number of new and modern motors have been ordered and will be put in service by the Norfolk & Western.

A HEAVY DECREASE IN THE NET INCOME of the Interborough Consolidated Corporation, which controls many of the subway, elevated and surface lines of New York City, was shown in the annual report of the company. From $3,263,910 in 1917 the net income last year shrunk to $724,914. Mr. Theodore P. Shonts, the president, assured the stockholders that there was no imminent danger of a receivership for the corporation as long as the dividends of the Interborough Rapid Transit Company, the subway subsidiary, could be continued.

THE GENERAL ELECTRIC CO. has announced the incorporation of the International General Electric Co. to develop the parent company's foreign interests and increase its export trade. The new company has a capital of $20,000,000, of which $10,000,000 is 7 per cent cumulative preferred stock and $10,000,000 common stock. All of the stock has been paid in and no public offering is contemplated. The directors in addition to Gerard Swope, president, include Gordon Abbott, A. W. Burchard, C. A. Coffin, George P. Gardner, J. R. Lovejoy, S. Z. Mitchell, G. F. Morrison, Charles Neave, E. W. Rice, Jr., and O. D. Young.

A STRIKE OF BOATMEN in New York harbor paralyzed local traffic on Tuesday, Wednesday and Thursday of this week, the passenger ferries of the Delaware, Lackawanna & Western being the only railroad craft which were kept running. Embargoes were placed in all directions against freight for New York over routes which have to use ferries or floats to reach the city, and the outbound freight stations on the docks refused practically all shipments. Passengers crossed the river, with some delay, through the tunnels. As we go to press it is expected that the Railroad Administration will grant the eight-hour day and other demands of the strikers; but the attitude of the owners of other boats has not been disclosed.

IN BEHALF OF ENGINEERS WHO HAVE BEEN SERVING in the army or in government capacities during the war, it is the desire of the Engineering Societies' Employment Bureau, New York City, that state and municipal authorities, corporations and individuals who need the services of professional engineers communicate their wants to the Bureau, 33 West Thirty-ninth street. This bureau is maintained by the four national Societies of Civil, Mining, Mechanical and Electrical Engineers. By resolutions adopted unanimously (by the 650 members present at its annual meeting) the American Society of Civil Engineers has recorded "its profound conviction that public works should be carried forward to the fullest extent consistent with sound judgment, not only for fundamental economic reasons, but for humanitarian reasons."

FOURTEEN BALES OF SILK were thrown out of a car of a westbound freight train of the Delaware, Lackawanna & Western, west of Stroudsburg, Pa., on the morning of February 20, about two o'clock, and some thieves were waiting to carry off the freight in automobile trucks; but it is said that the railroad police and employees thwarted the plan of the robbers and recovered the silk; and one man is under arrest. It appears that the car containing the silk was watched all the way from Paterson, N. J., 69 miles, to a point beyond Stroudsburg, and that the theft occurred within a section of three miles between the point where the watchmen left the train and where other watchmen were to board it. The Scranton Times, which reports the occurrence, believes that one robber had secreted himself in the car before it started from Paterson and that other robbers followed the train all the way in automobiles. Among the measures taken to capture the robbers was the sending out of locomotives to stand on highway crossings and thus interfere with the movement of automobiles.

General Electric Company's Exhibit at Chicago

The General Electric Company, Schenectady, N. Y., is represented at the exhibit of the National Railway Appliances Association at the Coliseum, Chicago, by a variety of apparatus of great interest to railway engineers.

Among the devices shown are turbo-generator headlight sets, battery charging sets, switchboards, resistance units, lantern slides and photographs show-

ing various installations of electrical equipments of interest to railroad men, and a lead burning transformer.

The company is represented by John Roberts, H. W. Stewart, H. M. Jacobs, and L. W. Shugg of Schenectady; W. H. Sigourney of New Haven; C. Dortices, A. J. Francis, and A. P. Jenks of Chicago; R. G. Standerwick, of Lynn, Mass., and E. K. Shelton of Pittsfield, Mass.

Proposed Salaries for Engineers

The American Association of Engineers has submitted to the United States Railroad Administration a schedule of proposed salaries for technical engineers employed by the roads. This schedule is a result of the work of a railroad committee of this association appointed to study this problem when it became evident that the complications involved were delaying its definite solution by the Railroad Administration. In the case of chief engineers, assistant chief engineers, chief draftsman, superintendents of motive power and assistant general superintendents of motive power the schedule makes no specific recommendation; the salaries should be "commensurate with the duties performed." With each position this list contains a note indicating the duties, responsibilities and scope of authority of the position.

Position	Railroads having over 5,000 miles of track	Railroads having less than 5,000 miles of track
District engineer	$425	$375
Assistant district engineer	350	300
Division engineer	375	350
Resident engineer	275	275
Assistant engineer	275	275
Engineer of bridges	400	350
Valuation engineer	400	350
Assistant valuation engineer	350	275
Mechanical engineer	400	325
Electrical engineer	325	275
Assistant electrical engineer	275	250
Signal engineer	400	350
Assistant signal engineer	300	275

Proposed Electrification of Swedish State Railways

According to a report issued by the Administration of the Swedish Railways, the plan of electrifying the whole of Sweden's railway system is now approaching its realization, says the Railway Gazette of London. In 1915 the Railway Administration found it necessary to make a closer inquiry into this question, as it appeared that the high cost of fuel made it advisable to adopt electrical power. It is estimated that if the transition had been made in the year 1913 it would not have cost more than the actual cost of fuel in 1915. As the war proceeded it was found necessary to have recourse to wood instead of coal for firing the engines, and this naturally considerably reduced the speed. That, however, was not the worst of the matter. In the year 1917 40,000,000 cubic meters of timber were consumed, whereas the annual increase in the supply of timber was only 25,000,000 to 30,000,00 cubic meters, and at the same time a large quantity of coal was also used. The steady increase in the time of the train journeys was also a serious matter. A journey from Stockholm to Kiruna (Lapland) now occupies 39 hours; with electrical working the journey could be done in 18 hours. The journey from Stockholm to Gothenburg now occupies, even in the most favorable circumstances, 11 hours, whereas an electrically-driven train could do it in 5½ hours. The Railway Administration estimates that the electrifying of the railways can be carried out in about 10 years. There is plenty of water power in the country, and already several large power works are in existence. It is also suggested that cables strung along the railway lines will be able to supply power for agricultural purposes.

The E. S. B. Company Holds Convention

The Electric Storage Battery Co., Philadelphia, recently concluded their five day "Victory" convention, which was held at the Bellevue-Stratford Hotel.

The officers of the company, the sales managers from the various branch offices throughout the country and the heads of departments were in attendance.

Plans were discussed and formulated at all of the daily sessions to meet the increased demand for the company's batteries for commercial purposes.

The company's activity in war work, consisting of the supplying of batteries in large quantities to the U. S. Government, to a large degree ceased with the signing of the armistice. This release from war work again places the E. S. B. Co.'s factory on a peace working basis so that the battery requirements of varied industries can be cared for. All of the company's products, the "Chloride Accumulator," the "Tudor Accumulator," the "Exide," "Hycap-Exide," "Thin-Exide," and "Ironclad-Exide" batteries are once more available for commercial use.

A "Victory" banquet at the Germantown Cricket Club closed the convention.

Electrify Italian Railroads

The railroads in Italy are gradually undergoing electrification, and with this development also is coming steadily the question of municipal and state control of this important utility. And so out of her enormous war sacrifices and endeavors to meet unheard of conditions and conquer an enemy that seemed to have everything that nature could supply and hand of man could devise, Italy has brought into active development a new force to help her take her place as one of the foremost industrial nations in the world.

"The after-war period will witness development of domestic workshop labor in preference to factory work, an evolution especially welcome to the war mutilated," says Guido Ressata, the well known Italian economic writer. "This evolution is made possible," he said, "by the easier manner in which electric energy can be distributed in comparison to steam, and will further promote the electrification of Italy. In the south especially, it will be identified with the irrigation necessary to more intensified agriculture."

Since the war the Italian Government has taken effective measures to prevent monopoly, through priority claims, of the hydraulic energies of the country. This

industry has stimulated an important domestic manufacture of electrical machinery, employing many thousands of people, at the present time, in turning out high class machines which find a market all over the world. There is still, however, a wide field offering a great opportunity in Italy for the American manufacturer of electrical machinery, especially so as the German competition of the pre-war period is now entirely eliminated.

PERSONAL

J. H. HAMMER, electrician on the Chicago & Northwestern, with headquarters at Chicago, recently resigned to become chief electrician of a mining company at Ironwood, Mich.

O. E. BERGGREN has been appointed northwestern representative of the A G A Railway Light & Signal Company, vice H. E. Gifford, resigned. Mr. Berggren's headquarters are at 857 Peoples Gas building, Chicago.

N. ETTEN has been honorably discharged from the navy and returned to his former position as electrician on the Chicago & Northwestern, with headquarters at Chicago. Mr. Etten enlisted in the navy in June, 1918, as chief machinist mate.

GEN. GUY E. TRIPP, chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, has sailed for England. He was accompanied by several officials of the company and it is expected that the party will be away for about six weeks. The purpose of this trip is to further plans for enlarging the export business of the company.

C. W. JOHNSON, of the Westinghouse Electric & Manufacturing Company has recently been appointed to the position of assistant manager of works. After graduating from the Ohio State University, Mr. Johnson entered the employ of the Steel Motor Company of Johnstown, Pa. A year later he became associated with the Bullock Electric Company of Cincinnati, Ohio, and in 1904 was made superintendent of the Allis-Chalmers-Bullock, Ltd., of Montreal, Canada. In 1907 he entered the employ of the Westinghouse company, being appointed chief inspector of works, later being promoted to general superintendent, in which capacity he served until his recent appointment. Mr. Johnson is a member of the American Society of Mechanical Engineers, American Institute Mining Engineers and the Engineers Society of Western Pennsylvania.

OBITUARY

D. J. JONES, electrician on the Chicago & Northwestern, with headquarters at Chicago, who was on a leave of absence, died on February 12 at Louisville, Ky.

TRADE PUBLICATIONS

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., recently issued its 1919 catalog on 2-8 wiring devices (first, second specialties). The new catalog contains 64 pages illustrating and briefly describing the various devices.

The National X-Ray Reflector Company, Chicago, Ill., is distributing the January-February number of its house publication "Eye-Comfort." As usual the pages of this publication are devoted to the illustration and discussion of lighting installations.

The Appleton Electric Company of Chicago recently published catalogue 8 entitled "Unilets" and other conduit fittings. The catalogue consists of 160 pages, largely devoted to descriptive matter, catalogue numbers, weights, etc., with the first 14 pages devoted to index, both tabular and pictorial.

The Thompson Electric Company, Cleveland, Ohio, is distributing a small envelope folder entitled, "Do Your Reflectors Reflect?" The folder illustrates the uses of the Thompson safety disconnecting hanger, which disconnects the lamps from elevated positions so that they may be lowered and more readily cleaned by the lamp maintainer.

The Trumbull Electric Manufacturing Company, Plainville, Conn., is busy distributing its February number of "Trumbull Cheer." In accordance with its usual practice this little 14-page pamphlet is devoted to timely wit and humor, a generous percentage of which relates to matters concerning the war. Of particular interest is the list of the things which Germany would have demanded from the Allies if she had won the war. A rather insignificant portion is devoted to the illustration and description of some of the latest Trumbull equipment.

The Dearborn Chemical Company, Chicago, Ill., has issued a booklet entitled The Prevention of Rusting or Corrosion of Iron and Steel, for the purpose of presenting evidence of the success that has followed the use of No-Ox-Id, a rust preventive developed by the Dearborn Chemical Company, as well as to describe other Dearborn products, including Dearborine, a preparation for cleaning machined parts of emery or grease, Klean-Kleen, for use in cleaning metal during various stages of manufacture, and cutting, quenching and drawing oils, etc.

Central Electric Company, Chicago, is distributing two illustrated envelope folders. One of these is devoted to the description of porcelain sockets which include the key, keyless, pull and locking variety. The second folder shows and describes the "Never Creep" anchor. From the illustrations in this folder it is evident that much time can be saved by the use of this anchor since a single bored hole is all that is required for its installation. The particular virtue of the "Never Creep" anchor is that it pulls entirely against solid virgin earth instead of against filled-in earth as is the case with many types of guy anchors.

Wilson Welder & Metals Company, Inc., New York, are distributing a 24-page pamphlet entitled "Repair of the German Ships." A large number of photographs are shown illustrating the damage done to the engine equipment of these vessels and of their subsequent repair by the Wilson plastic-arc welder. Other portions of the pamphlet are devoted to the illustration and description of the various welding machine parts and equipment. It has been estimated that at least a year was saved in time and approximately $20,000,000 by the reclamation of these German vessels by means of electric welding.

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WHERE THE MONEY HAS GONE

One of the most important steps taken by the Railroad Administration during the past month by way of improving its financial condition has been the elimination of punitive overtime in every instance where it has been found possible and practical. By changing the working hours of men in some departments from twelve hours to eight hours, a number of distinct advantages have been secured. In the first place it is obviously cheaper to employ three men to cover a certain job during a twenty-four hourly period on a straight hourly basis than it would be to employ two men, each of whom would receive time and a half for four of the hours that they were on duty. It has been estimated that a direct wage saving of four per cent can be effected among men who have heretofore been working the four hours overtime in addition to their regular eight-hour day. Not only will a direct financial saving be made, but greater efficiency will be gained and better service rendered. Furthermore, the additional trick added to the twenty-four hour period will be the means for providing work for many of the men who have been released from military and naval service. This in itself is a very important factor at the present time.

It cannot be denied that the punitive overtime has been the cause of no small part of the deficit of the railroads during the past year. In many cases men have received wages that were out of all proportion to the service rendered.

SYSTEMATIC SAVING

There are two great reasons why the coming Victory Loan should appeal to the railroad man. The first is that he is a good workman and as such knows that every job must be finished. He has done his share in the four Liberty loans and he is not going to fall down on the job until it is finished. The second is that it affords him an opportunity for systematic saving. Railroad men, as a class, have the reputation of being good spenders but poor savers. The first four loans, however, have shown most of them the value of saving a little.

On a purely commercial basis the Victory Loan should appeal particularly to railroad men. There are thousands of railroad employees and probably hundreds of junior officers of railroads who have been successfully and systematically saving money, becoming capitalists, for the first time in their lives through the purchase, on the installment plan, of the various issues of Liberty Loans. The terms offered by the Railroad Administration are very liberal. When a man stops to think how large a proportion of his first premium payment on life insurance goes to pay the cost of soliciting the policyholder—commissions to solicitor—he can appreciate much better the liberality of the Railroad Administration now, and of the railroad companies in the past, in undertaking, free of all charge or commission, this great work of bond solicitation.

Such a great majority of all the railroad men in the country were subscribers to one or more of the Liberty Loans that the work of introducing the investment to them should, in the case of the Victory Loan, be almost nil. It is rather a question of arousing enlightening self-interest and this should not be difficult. Systematic saving is an absolute requirement for success in life, whether a man be earning one hundred dollars a month or one thousand dollars a month. Never before has there been such an opportunity to save on such advantageous terms, or in so easy a way.

WHO IS THE ENGINEER?

To the greater number of railroad men the term engineer presents a picture of the man with his hand on the throttle, and there is no disputing the fact that Casey Jones was an engineer. In the broad sense, however, the engineers are the men trained for civil, mechanical electrical, chemical and mining engineering, and they are the men largely responsible for our present day civilization. They are the ministers to human comfort, the connecting link between capital and labor, and they are the men who will eventually bring our country out of its present dilemma.

Most of our embryo engineers are produced by our various technical schools and colleges. Unfortunately, these schools have turned out very little engineering material during the past two years, and due to the fact that courses have been rearranged to meet war conditions, more time will be needed to return the schools to pre-war conditions. In a general letter from the dean of a large western engineering school to the alumni, he wrote as follows: "Scarcely anything connected with the university has been normal during the current year. Had not the demand upon the American army been enormously increased in 1918, it is likely that no considerable changes would have been made in the college courses, but the tremendous program decided upon early last summer and the draft law enacted to carry out this program had the effect of very greatly disorganizing the ordinary college work throughout the country."

A week ago the president of a large eastern college

said, "War has lowered the standards of education and a period of time will elapse before they can again be raised."

During the next few years, good engineers will be more at a premium than heretofore. Engineers will be required to make conditions on the railroads possible, and it will be up to the executives to keep the good engineers they have and to use them and to work with them to the best advantage. Furthermore it increases the opportunity for the young man who has not had a college training but who is willing to broaden his mind and better his job by reading and study outside of regular working hours.

LETTER TO THE EDITOR

Locomotive Wiring

To the Editor:

In the November issue of the *Railway Electrical Engineer* there appear several discussions of committee reports presented at the last convention of the Association of Railway Electrical Engineers. I have read with considerable interest the discussions on electric headlights. There seems to be some difference of opinion as to the best practice in wiring locomotive cabs. I favor open work as against conduit.

Open wiring in locomotive cabs was adopted several years ago by the road on which I am employed, because of the low cost, its simplicity and durability, all of which are essential to keeping locomotives in service, and eliminating delays, and failures which in my opinion cannot be avoided by the use of conduits, fittings and accessories. This has actually been proved by tests.

The cost of labor and material for open wiring on a locomotive is $10 as compared to $50 for conduit fittings, material and labor, resulting in a saving of $40 per cab. At the present time we have 1800 locomotives equipped with open wiring in cabs, which cost $18,000. Assuming the same locomotives had been equipped with conduits the cost would have been $90,000. From a money value standpoint, $72,000 has been saved by installing open wire work in the cabs.

As to simplicity, take for instance our drop cord for the steam gage lamp. It consists of one wall socket mounted on the ceiling of the cab, one Benjamin swivel screw plug, four feet of reinforced lamp cord with the same amount of loom and one keyless socket. With this drop, trouble can be located immediately and repairs can be made quickly. We use a 60-ampere single pole, double throw switch, which is secured to the ceiling of the cab with four No. 8 wood screws. Its application is simple and economical, all connections are in plain view and in case of a broken wire or loose connection the trouble can be located easily. If, however, an enclosed switch were used, it would require considerable time to locate trouble, which is expensive.

On the other hand conduit is neat and makes a nice looking installation, especially when the electricians take particular interest in this class of work. The use of conduit might be recommended on some main lines where the locomotive wiring is more liable to be maintained and repaired by competent electricians, but on small roads and branch lines such installations may be objectionable on account of the possibility of inexperienced men being placed in charge. It is my opinion that the gas from locomotive fireboxes will attack the conduit fittings and screws, corroding them and making it possible to make quick repairs.

One objection that has been raised against open wiring is that engineers and firemen put files, timetables, waste, etc., behind the wires, which has a tendency to cause the wires to sag and the cleats to loosen. In answer to this I might say that we have never had a single failure due to cab wires becoming loose when wood screws are used in the cleats. I have heard, however, that such trouble existed when nails were used.

As to the durability of cab wiring, it generally happens that locomotives are sent to the shop for repairs and overhauling about every two years. As a consequence, the cab wiring has to be removed. If it happens to be conduit, the job, when replaced, usually is a patched one, and the cost is excessive. If the cab is open wired it can be replaced entirely new for one-fifth the cost of conduit work.

A. I. Peters,
Chief Electrician 40th St. Shops, C. & N. W. Ry., Chicago.

NEW BOOKS

Electrical Goods in China, Japan and Vladivostok. By R. A. Lundquist. 197 pages. Published by the Bureau of Foreign and Domestic Commerce, Government Printing Office, Washington, D. C. Price 30c.

The report contains much useful information concerning the use of electrical goods in the parts of the world mentioned, as well as giving an excellent idea of the business methods, customs of the people, climatic and other conditions. The book is really a valuable source of information on electrical matters, containing many specific facts and figures.

Training for the Electric Railway Business. By C. B. Fairchild, Jr., executive assistant, Philadelphia Rapid Transit Company. Written under the supervision of T. E. Mitten, chairman, executive committee, Philadelphia Rapid Transit Company. 155 pages, 9 illustrations, 5 in. by 7½ in. Published by the J. B. Lippincott Company, East Washington Square, Philadelphia, Pa. Price $1.50.

The function of this book is to present the demand and requirement of the electric railway business to the young man who is about to choose an industry. It outlines the organization of the business, names the officers required and explains the duties of each officer.

The book is divided into five parts as follows: Organization, the executive and transportation functions, the engineering functions, the administrative functions, and miscellaneous functions. Each of these five phases of the business is explained briefly and in order, so that a single reading of the book will furnish a very complete and well defined picture of the subject. For example, in the section dealing with the executive and transportation functions appear such subjects as the executive, the manager's duty, the morning mail, the day's work, transportation, public service and timetables, and the motormen and conductors.

The book is written primarily for the young man looking forward, but owing to the fact that it outlines the entire subject briefly, it furnishes the railway officer an opportunity to get a more comprehensive view of his own work.

New Haven Installs Model Charging Plant

Obsolete Equipment Formerly Used in Dover Street Yard, Boston, Replaced by Complete Modern Installation

THE plant takes care of cars in three yards, including both New Haven and Pullman cars. The installation in No. 1 yard is finished and work is in progress in yard No. 3. Only a few cars in yard No. 2 need attention and no special provision is made for charging these. When it becomes necessary to charge a car in yard No. 2 a cable is led over to it from yard No. 1, and the car is charged in this manner.

The plant is equipped for charging, cleaning and repairing both lead and alkaline batteries and equipment, and both 30 and 60-volt systems are taken care of. There are, however, only diners and one private car which come into the yard which are still fitted with 60-volt equipment and it is hoped that these may soon be changed to 30-volts, as charging 60-volt cars requires that a special connection be made at the cars.

Arrangement of Plant

The plant itself, Fig. 1, is a one story brick building, 140 ft. long and 18 ft. wide. In one end of the building is the charging power sub-station. This is operated by the New York, New Haven & Hartford and the New Haven men charge both the New Haven and the Pullman batteries. The rest of the building is divided between the Pullman Company and the New Haven and each company has its own separate rooms and facilities for cleaning and repairing batteries and repairing and overhauling the various mechanical parts of car lighting equipment.

Three-phase, 60-cycle power is brought to the building at 2,300 volts. A bank of three 37.5 kva. transformers mounted on a platform between poles at one end of the building, as shown in Fig. 1, is used to step the voltage down to 440 volts. From the transformers on the platform the 440-volt three phase power is brought into the building by lead covered cable in galvanized rigid metal conduit.

Charging Power Sub-Station

The charging power sub-station is a cement floored room, 18 ft. by 35 ft. in size. The arrangement of the machine and switchboard is shown in Fig 2. There are two 3-machine sets now in use and provision has been made for two more similar sets. These sets each consist of a 3-phase, 60-cycle, 440-volt, 75-hp., squirrel cage type induction motor, driving two, 35-kw., 75-volt, flat compound wound direct current generators.

The seven paneled switchboard on the right, Fig. 2, is a General Electric control board for the machines. The motors are protected by inverse time limit relays arranged to trip the starting compensator and the generators are protected by both overload and reverse current relays arranged to trip the circuit breakers at the top of the panel. The blank panels provide for additional machines.

The four paneled switchboard, shown on the left, Fig. 2, is an Allen-Bradley charging switchboard. The panels 1 and 2 are used for controlling the current in any charging circuit and plug cables are used on panels 3 and 4 to connect the power to any desired circuit in the yard.

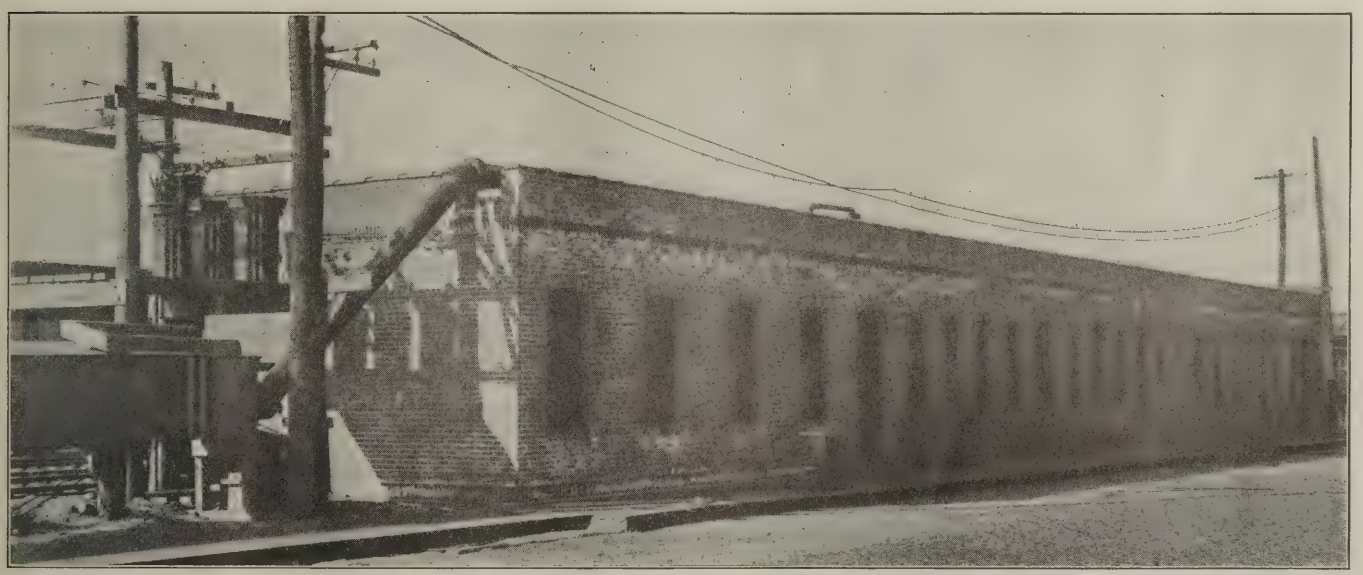


Fig. 1—New Brick Building Contains Charging Power and Separate Battery Cleaning and Repair Rooms for Both the New Haven and the Pullman Company.

Distribution System

Yard No. 1 is a terminal yard and is now completely equipped with charging outlets. The charging plant is about 200 ft. away from one corner of the yard and the 53 individual circuits are carried underground from the plant to a manhole at the nearest point of the yard in lead covered cables through creosoted wood duct. A half way manhole provides a pull-box for the cables.

The circuits are brought out of the manhole at the yard in rigid metal conduit and these conduits extend across the end of the yard at right angles to the track.

They rise from the manhole and extend along a wall at the end of the track, as shown in Fig. 3.

There are 24 tracks in the yard and a branch run of conduit extends between every other track. Junction boxes on the wall are provided for these branches, as shown in Fig. 4.

The branch runs are laid on top of the ground and there are from three to six outlets per branch, or from three to six outlets for each pair of tracks. A Crouse-Hinds outlet box is used for each outlet, as shown in Fig. 5. This illustration also shows how the conduit is laid along the ground beside the tracks. For the greater part of the run it lies on the ties outside of the rail.

Fig. 2—Charging Power Substation

Wiring Scheme

The wiring plan is an unusual one for railroad charging plants as it is a three wire system. There are two generators in each set of machines of opposite polarity. The two generators in either set are in series so there is a voltage of 150 across the outside wires and if desired the two plus machines or the two minus machines can be used in parallel.

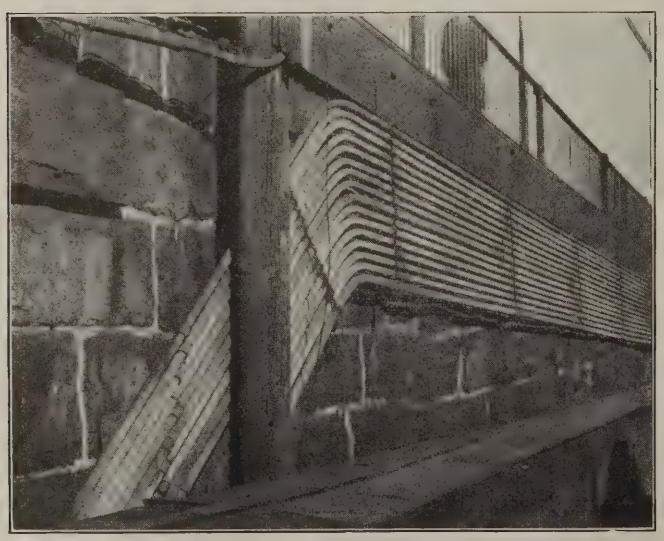


Fig. 3—Metal Conduits Which Carry the Charging Circuits from the Manhole to the Branch Boxes

A diagram of the wiring is shown in Fig. 6. The diagram shows one battery, B-1, on charge between the negative and the neutral. One battery, B-2, on charge between the positive and the neutral, and one battery, B-3, on discharge.

The batteries, B-1, B-2, and B-3, are batteries in three different cars and S-1, S-2, and S-3 are the corresponding car charging receptacles. The leads, P-1, C-1, etc., are the two wire cables which extend from the car receptacles to the yard receptacles, such as shown in Fig. 5. The receptacles marked 1, 2, and 3, are those in the two right hand distributing panels of the charging switchboard shown in Fig. 2.

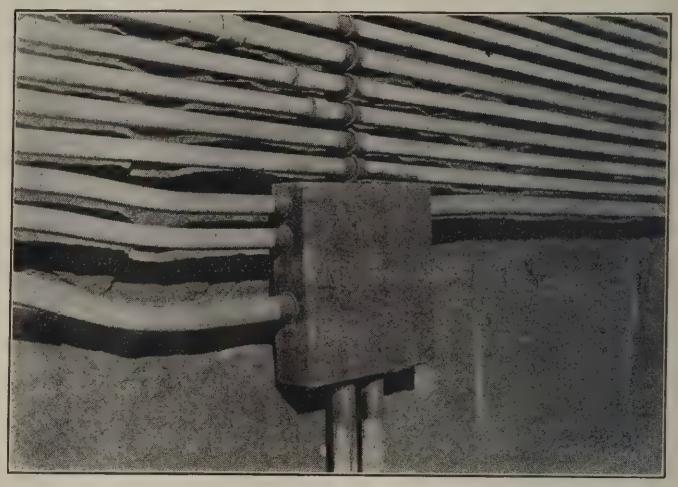


Fig. 4—Type of Branch Box Used to Connect Branch Circuit to Main Run of Conduit

Charging Board Presents Unique Feature

When a man out in the yard plugs a car battery into one of the yard receptacles, that line is made live back to the charging board and that fact is made known to the switchboard operator by an indicator on the distributing panels. A close-up view of two of these indicators and their corresponding receptacles is shown in Fig. 7. When the circuit is made live the slot in the center of

Fig. 5—Outlet Box from Which Car Is Plugged Into a Charging Circuit

the indicator shows white. In addition, the plus or minus sign beside the slot indicates that this circuit must be connected on either the plus or the minus machine. The indicators will operate at anything from 28 to 75 volts.

The operator is thus notified that there is a car battery waiting to be put on charge. He then selects a cable from the rack and plugs this circuit on with any one of the 20 charging circuits on the two left hand panels of the charging board. There are 20 charging circuits two of which are also used for discharging circuits. One of the charging switches and the handle for operating the rheostat in that particular circuit is shown in Fig. 8. The switch is shown in the open position and if the indicator on the distributing panel was marked plus the switch is thrown to the left and the current is adjusted by the rheostat. If the indicator was marked minus

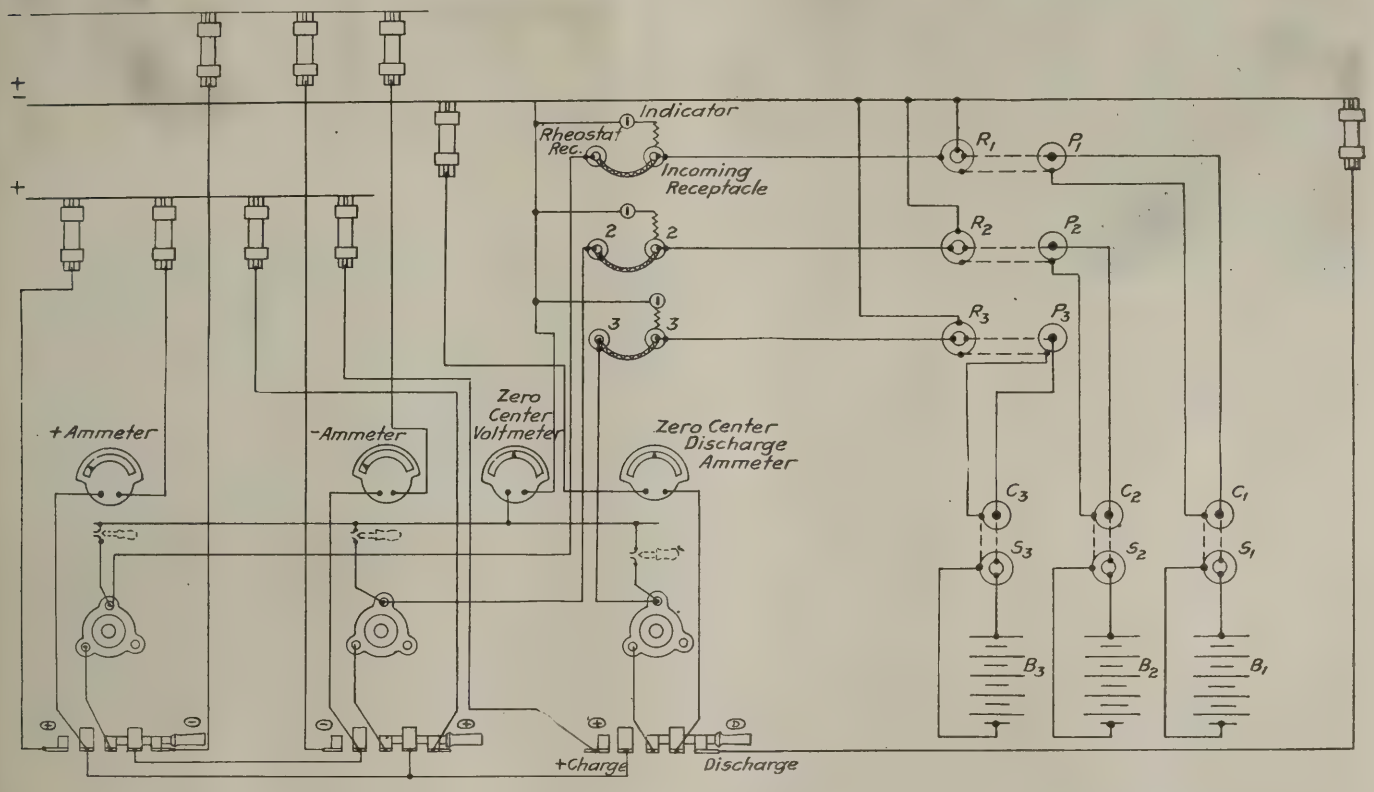


Fig. 6—Wiring Diagram, Including Circuits from the Generator Terminals to the Car Batteries

of course the switch must be thrown to the right and the battery thus connected to the negative machine.

To obtain a reading of the current, the switch is raised from the lower to the upper contact. This puts one of the ammeters on the bracket meter panel, shown in Fig. 2, in series with the circuit. There are two charging ammeters, one discharge ammeter and a voltmeter on this panel. The voltmeter may be connected to any charging circuit by inserting a special voltmeter plug in any one of the 20 voltmeter receptacles. Two of these receptacles are shown in Fig. 8.

The charging resistance consists of a four-unit graphite pile resistance and the same resistance are used for both charging and discharging. The four units are connected in series and the single screw operated by the rheostat handle exerts an equal pressure on all four of the graphite piles.

It has been found that if a 60-volt battery is connected to any one of the individual charging circuits, it is not possible to charge at a rate of more than 20 amperes. For this reason a special connection is used for charging a 60-volt battery. Two of the yard circuits are used and there are two possible methods. In one, the battery is split and each half charged on a separate circuit, and in the other, the positive from the plus machine is connected to one side of the battery and the negative of the minus machine is connected to the other side of the battery. This second method also requires that two circuits be used, but it is not necessary to split the battery.

Cleaning and Repairing Batteries

The room in the plant next to the charging power sub-station is fitted for cleaning and repairing batteries. It is 18 ft. by 47 ft. 3 in. long, the floor is made of vitrified brick with asphaltum filling and all wood work is painted with acid proof paint. It is piped for gas, water, steam and air and is provided with six charging receptacles.

In the room there is a wash bench, a lead burning bench with oxy-hydrogen equipment for burning lead, a petrolyte heater, a plate press, a rack for holding battery repair parts, tanks for holding old electrolyte, new electrolyte, water and for sediment and a gas operated water still.

When a battery is taken from a car to be cleaned or repaired, it is slipped out of the car battery box on to a four-wheeled truck which is approximately the same height as the battery box. It is then taken to the cleaning room.

First the cover is removed; the petrolyte seal around the cover being melted with a steam cover. There is one of these for each type of lead cell crate and they consist of a wooden box without a bottom, about 8 or 10

inches high, which is just large enough to cover the top of the battery crate without sliding down over it. The inner side of the edges of the box which come in contact with the battery crate are bevelled and covered with sheet rubber packing. There is a handle at the top and a hole in the end large enough to admit a steam hose. Steam is blown into the box through this hole

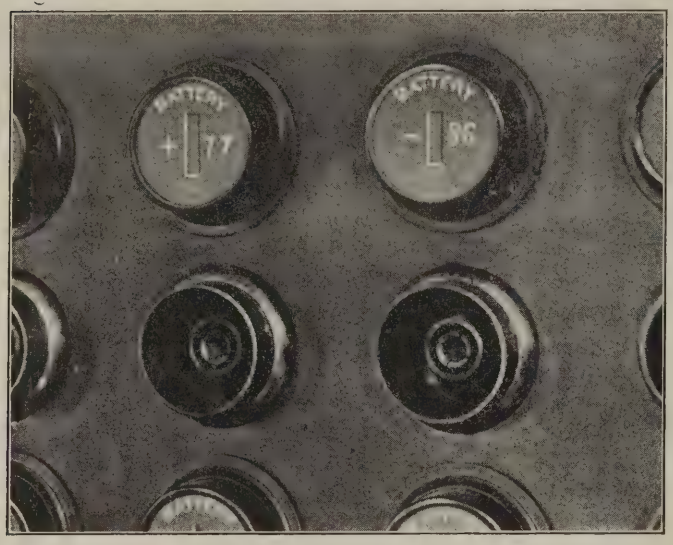


Fig. 7—Indicators and Their Corresponding Plug Receptacles on One of the Distributing Panels of the Charging Switchboard

and when the seal has been melted the cover is lifted off.

After the cover is taken off, the plates and separators are lifted out. For plates that are badly warped and swollen an air operated device will be provided for pulling the plates out of the tank.

For cleaning, the crates and tanks are slid off the truck on to the wash bench which is just the same height as the trucks. This bench is shown in Fig. 9. If the old acid in the cells is good enough to use for repair

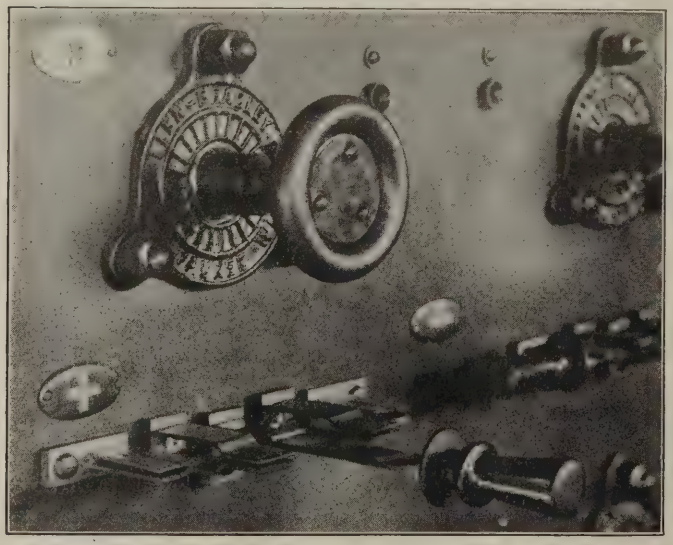


Fig. 8—Charging Switch and Handle for Operating Charging Rheostat

jobs it is poured into a lead lined tank which ordinarily stands alongside of the wash bench and which is the same height as the wash bench.

The bench is lead covered and designed so as to drain toward the center. Four mitered wooden racks on top of the bench protect the lead cover and under the drain in the center is a lead lined tank. This tank catches the sediment and is fitted with an overflow which allows the water to run into the sewer. This tank is dragged out from under the bench when it is necessary to empty it. The lead battery tanks are flushed with the hose and water connection shown over the bench in Fig. 9. One of the trucks for hauling the battery from the cars is shown at the right.

General Practice

All lead batteries that do not develop trouble are cleaned at intervals of not more than 18 months. At this time the old electrolyte is replaced, warped plates are straightened, growing plates are trimmed, damaged plates, risers, and connectors are repaired, tanks are inspected and repaired if necessary and are coated with petrolyte, crates are repainted and repaired and all connections are put into first class condition. Conveniences make this work possible with the least expense.

A vertically mounted air brake cylinder is used for a plate press and wooden spacers are used between the

Fig. 9—Battery Washing Bench and Truck Used to Move Batteries from the Car to the Plant and Back to the Car

plates of a group while they are being pressed. A hand saw is used for trimming groups of plates and bench shears for cutting sheet metal are used for trimming separate plates. Some very successful experiments have been made in which plate groups were cut with a rotary cutter, but this equipment has not as yet been permanently installed. The petrolyte tank is heated with a gas flame and the petrolyte tank is deep enough to allow the battery tank to be dipped into and completely covered with the hot petrolyte.

The central part of the plant is fitted with toilets and wash room which are used by both the Pullman and New Haven men. The equipment used by the Pullman Company is very similar to that used by the New Haven, except that the facilities for cleaning and repairing are not as large and more room is left for shop work and mechanical repairs.

The plant was designed by the engineering and mechanical departments and built by the engineering and maintenance departments.

Electric Arc Welding Principles*

Describing the Practice Concerning Metals Used Their Application and Electrical Characteristics

By E. Wanamaker and H. R. Pennington

ONE of the questions which arises in the minds of those who are considering the use of an electric arc welding process, is the quality of the metal applied, and the weldability of the various kinds of metals, of which there are only a few that cannot be welded successfully by means of arc welding processes. Metals that can be used are usually rolled into wires or small rods which, when melted by means of arc welding, cool into a cast form in which the artificial structure produced by the rolling is entirely changed. In the application of the welding process the above statement should not be forgotten. Iron and steel are the metals best adapted for the work, although many metallurgical problems concerning their use has brought about considerable research and some of the leading metallurgists of the United States and Europe are carrying on extensive investigations. The observations which have been made up to the present time seem to indicate that the only elements present, which affect the welding process to any extent are carbon and manganese. Steel that contains 0.5 per cent or more of carbon when welded under conditions where the weld is exposed to the air, is subject to "burning". This is caused by the combustion of the carbon with the oxygen of the surrounding air. Manganese, like carbon, has a great affinity for oxygen and likewise is harmful to the weld. It has been demonstarated that with the proper weld protection, the detrimental effects of the air can be largely overcome, permitting the use of a metal of such composition as to give the weld the proper quality for most practical purposes.

The crystalline structure of a weld is governed largely by the rate of cooling of the metal. Slag inclosures are a common source of weakness in welds but are of minor importance, especially when the proper precautions are taken. Gas pockets occur in most all welds and are thought to be from the gas forming impurities present in the electrode material. Gas has little or no effect on the deposited metal but often causes a very unstable arc. The impurities that are present in all welds are undoubtedly the cause of the tendency toward brittleness, and can be entirely overcome only by the elimination of nitrides and oxides, but this does not mean that welding has not yet reached a point of practical application. Its usefulness and economy have been demonstrated in the industries to such a large extent that its permanency is assured. There are no technical problems of importance yet unsolved which have weight enough to hold back the extension of the process into other fields where the older methods of joining metals are being used.

Arc welding properly done can be relied upon to produce a joint having a strength at least equal to that of riveting. Proof of this is to be found in the fact that the process is being used for the construction of locomotive boilers, tanks for all purposes such as air, gas, oil, ammonia, steam, etc. Arc welding is also used for constructing pipe joints, repairing broken locomotive frames, car couplers, bolsters, truck frames, cross heads, engine castings and many other parts. All these are being successfully welded. The engines on the interned German ships, which were broken by the crews, were repaired by the same method. In repair shops it is used successfully for building up worn parts or fittings which have been machined under size by mistake.

Tentative regulations were prepared for the application of arc welding on ship construction. This indicates the progress of the art in that field. The actual welding of a modern sized merchant ship in the near future will not be a surprise to those closely associated with arc welding. Mention has been made of the adaptability of the process to show that it is in the practical state of application and development. More specific data as to the behavior of the metal affected by the welding, as well as methods employed, will be covered in future articles.

The Electric Arc as Applied to Welding

In a direct current electric circuit the current flows in a definite direction namely: from the positive pole of the source through the circuit to the negative pole. When the circuit is interrupted, because of a break, an arc is formed at the gap, and the current flows across the intervening space. If for example, a carbon electrode and an iron plate as shown in the illustration are connected with the terminals of a sufficiently powerful source of electricity and the carbon is brought in contact with the plate and gradually separated to a distance of about ¼ in. the direction of the current being such that the electric steam leaves the plate, passes through the arc and enters the carbon rod or electrode, then the plate will be the positive and the carbon rod or electrode will be the negative. The positive electrode is generally indicated by a + sign and the negative electrode by a — sign.

In arc lamps used for producing light, the ends of the

*E. Wanamaker, electrical engineer of Rock Island Lines. H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. This article is the second of a series on Electric Welding. Copyrighted, 1919, by the *Railway Electrical Engineer*.

carbon electrodes are brighter than the flame between them and the carbons are of unequal brilliancy, the positive carbon being much brighter than the negative. Moreover all parts of the end of the positive carbon are also unequally bright; most of the light comes from the crater. Since the light giving property of a heated body increases rapidly with its temperature, an inspection of the arc will show the crater in the positive electrode is the hottest part of the arc. The positive electrode is often referred to as the anode, and the negative electrode as the cathode.

It is estimated that approximately 75 per cent of the resistance offered to the passage of electric current from the anode to the cathode occurs at the anode. The remaining 25 per cent of the resistance is in the vapor between, and in the cathode. It is generally believed that in short arcs such as are used in the arc welding process more resistance is offered by the cathode than by the vapor of the air. Since the amount of heat in any part of the arc or electrodes is proportional to the amount of resistance offered by that part of the arc to the passage of the electric current, it is evident that the visible arc or flame liberates a comparatively small percentage of the total heat of the arc. The largest part of the heat is liberated at the positive electrode.

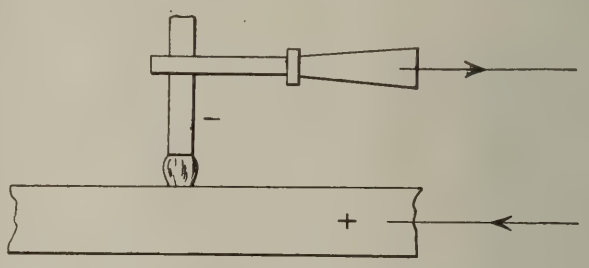
Polarity for Welding

Owing to the fact that the greater quantity of heat is produced at the positive electrode, in electric arc welding it is necessary to consider the matter of polarity. In metal electrode welding, the mass of the welding wire which is being melted is usually less than the mass of the piece to which the metal is being added so that the amount of heat lost by conduction is greatest on the latter piece. For this reason it is made the positive electrode. In certain cases, such as the welding of very thin sheet metal, the wire electrode is made the positive in order to reduce the tendency of the arc to penetrate through the sheet metal. Also with some coated electrodes the work is made the negative in order to reduce the penetration of the arc into the work. When alternating current is used for welding, it is obvious that an equal amount of heat will be developed at both electrodes. For this reason it would seem that a direct current arc has certain inherent advantages over an alternating arc when used for general welding.

Temperature of Electric Arc

If a vessel of water is heated so as to permit the vapor to escape into the air, the temperature of the water will not increase above that of its boiling point, namely 212 deg. F. under ordinary pressure. Under these conditions, the temperature of water at its boiling point is the temperature of its volatilization. This is a general law for volatilization of all substances where the vapor is free to escape. An increase in the temperature of the source has the effect of accelerating the volatilization and increasing the rate of the formation of vapor. In the same way it is believed that the temperature of the positive electrode or crater in the arc is thus limited to the temperature of the boiling point or volatilization of the substances between which the arc is formed. The temperature of boiling carbon has been estimated at 6,300 deg. F.

In the case of metallic electrode welding where an arc is drawn between two metallic substances we are led to believe, from the foregoing that the temperature of the arc, which will vary, depending upon the kind of metal used, is at least that required to volatilize the positive electrode to form metallic vapor. The maximum temperature is confined to a very small spot in the positive crater of the arc, and the temperature difference between that spot and the edge of the arc flame is very great. A certain amount of material is vaporized and is therefore lost in the same manner as water when it is vaporized due to its being heated to the boiling point. The small particles of iron oxide (sometimes called iron wool) seen floating in the air in the vicinity of a welding arc, come from the arc vapor. Deposits of this iron oxide may be



Sketch Showing the Polarity of the Welding Electrode and of the Work.

found on the surface of the material being welded and the rate of formation of oxide is governed largely by the extent to which the metal is exposed to the air. The extent to which the arc or the vapor column is exposed to the air will also affect the stability of the arc. The form in which the steel exists during its passage through the arc in metallic arc welding is at present the subject of much investigation. It is the general belief that the metal is in minute globules or in a stream of finely divided liquid. This conclusion is based on the theory that there must be an interruption in the metallic circuit to permit the formation of the arc.

Relation of Heat and Current in Arc Welding

The electric arc transforms electrical energy into heat. One kw. hr. of electrical energy is equivalent to 3,413 B. t. u. Thus an arc in which the current value is 150 amperes and the voltage between electrodes is 20 volts, transforms 3 kw. of electrical energy into 10,239 B. t. u. in one hour of continuous operation. Three kw. hrs. of electrical energy produces the same amount of heat as may be produced by approximately 6.6 cu. ft. of acetylene burned in 7.5 cu. ft. of oxygen. In electric arc welding the heat is localized in a very small area, and fusion or welding begins at the instant the arc is drawn so that comparatively little heat is lost by radiation. Present practice requires maximum power demand at the arc of 200 amperes at 20 volts for each operator using metallic arc welding. For carbon arc welding the power demand at the arc is approximately 300 amperes at about 35 volts. If cutting is to be done a current of at least 400 amperes is required. The approximate current and voltage required for the various sizes of electrodes, and for the various classes of work, will appear in articles to follow.

Influence of Air Upon Arc Welding Process

When an arc is formed between two carbons a dull incandescence can be observed, accompanied by a bluish lambent flame over the ends of the electrodes. This

flame is similar to that which exists over the surface of a hard coal fire when the supply of air is insufficient and is due to the burning of the carbon vapor in the oxygen of the surrounding air. It is believed that in the interior of this flame little or no oxidation of carbon vapor occurs, because the vapor tends to fill this interior space and therefore displaces the air. This is analogous to the welding arc; that is the molten metal is oxidized to a certain extent by the oxygen present in the atmosphere surrounding the arc. This oxidation is detrimental to the metal and the extent to which it occurs depends largely on the nature of the arc.

The crater of the arc under certain conditions does not maintain its position, but shifts at irregular intervals from point to point over the surface of the positive electrode, or in the case of welding, over the work or the part to which metal is being added. The cause of this shifting is explained as follows: as the material is consumed the crater becomes unequally worn at different parts and the arc tends to be established at the point where the distance is the least; slight impurities or irregularities either in the wire electrode being consumed or on the surface or in the metal of the part to which metal is being added will cause a shifting of the arc, as that portion of the metal which volatilizes most readily tends to become the center of the crater. As the length of the arc increases the tendency is for the vapor to spread laterally in all directions over the surface of the part to which the metal is being added. This also accounts for the shifting of the arc.

It is evident that metallic arc welding can not be done where such a condition exists, and in order to eliminate it as far as possible it is necessary first, that the wire or metal electrode be free from impurities and uniform in structure and density; second, that the surface of the work or the mass to which metal is being welded, be perfectly clean; third, that a short arc be maintained in order that sufficient heat will be concentrated in a small area on the mass opposite the end of the wire electrode so as to bring this mass to a molten state, thus permitting the metal being deposited to unite with the mass being welded.

Since the amount of heat liberated in an arc is proportional to the amount of resistance offered by the arc to the passage of electric current through it, some consideration must be given to the difference between long and short arcs.

Conditions That Effect Resistance of Welding Arc

The resistance of a metallic arc (the vapor column between the two electrodes) like that of all ordinary matter, follows Ohm's law; that is, it varies directly with the length, and inversely with the area of cross-section, consequently if the area of the vapor could be maintained, as the length of the arc increased, the resistance of the column would vary directly with its length. This, however, is seldom the case, for as the length of the arc increases the tendency is for the vapor to spread laterally in all directions, increasing its cross sectional area, and it sometimes happens that the increase in the resistance caused by the increase in the length of the arc, may be more than compensated by the decrease in its resistance, due to the enlargement of the area of the cross section. If the current passing through an arc be maintained constant, the pressure at the terminals of the arc is always increased by increasing the distance between the electrodes. The apparent resistance of the arc is always increased by an increase in its length. All of this increase may not be exactly proportional to the length, owing to the tendency to lateral spreading. If the distance between the electrodes is maintained constant and the current through the arc is increased, then the apparent resistance of the arc may either increase or diminish. It will usually increase with short arcs such as are used for welding; that is to say when there is very little room for lateral spreading, and it will usually decrease when the arc is sufficiently long to afford ample room for lateral spreading.

In view of the foregoing, it is obvious that a slight increase in arc length may or may not reduce the heat, depending not only on the area of the arc, but also on the characteristics of the welding apparatus which regulates the welding current. In the case of a machine which tends to maintain a constant current flow regardless of the arc length, the power transformed into heat by the arc would be increased with an increase in the length of the arc, whereas the so-called constant watt or constant heat machine may reduce the heat in the arc, when the length of the arc is slightly increased. In either case the metal deposited with a long arc is always brittle and appears to be burnt. Furthermore, it does not unite with the work or mass being welded.

The knowledge of the characteristics of an electric arc such as has been explained, should be of value to the reader in understanding some of the many actions of an electric arc when applied to welding. We have learned for instance that a metallic vapor when exposed to the air is attacked by the oxygen; the air surrounding it is 77 per cent nitrogen and 23 per cent oxygen. The latter attacks almost all metals at a red heat, and some of them at a lower temperature. This tendency of the metal to oxidize is very harmful and leaves the metal without ductility, so that every precaution must be taken to prevent oxidation. Even in bare electrode welding much can be done to protect the metal in the weld. Among the most important things to be done to prevent oxidation is to work always on clean metal and maintain a short arc, for should the surface of the work be covered with dirt or scale, the arc will play around and will therefore be exposed to the air. In a long arc the molten metal from the negative electrode must travel through a long heated path to reach the point at which it is to be deposited and since the amount of oxidation depends upon the temperature of the metal and upon the time to which it is exposed to the oxygen, the resultant oxidation of the deposited metal is far greater than if a short arc is maintained. The tendency of the arc to extinguish is largely due to the effect of surrounding air, for should the vapor column be increased from the proper dimensions, the increased radiation will cause the vapor to condense and break the circuit, thereby extinguishing the arc; or, should the dimensions of the vapor column be maintained constant and the radiation increased by a draft of air, the arc will likewise be caused to break. In case of an alternating current metallic arc the effect of the air is very noticeable, as the metallic vapor tends to cool or condense with each reversal of the current. To sustain an alternating current arc where a bare metallic electrode is used, a voltage of at least 110 volts is required and even then it is very difficult.

It has been pointed out that the arc voltage will vary with its length, which is determined by the operator, and that there is an arc length that is best suited for welding, especially in the case of the metallic arc, if the best results are to be obtained. For bare metal electrode welding, the arc voltage will be from 15 to 20 volts. With some coated electrodes the arc voltage may be as high as 35 volts. When the metallic electrode is replaced with a carbon or graphite electrode, the arc voltage is approximately 35 volts. In all cases the arc is supported by a voltage somewhat in excess of the above values to sustain the arc and prevent it from breaking when the arc resistance is changed by variation in length or when dirt and oxides are encountered. For direct current metal electrode welding, the arc voltage plus the available supporting voltage will range from 35 to 75 volts. For direct current carbon arc welding a total of approximately 70 volts is generally used.

With those closely associated with actual commercial welding, it is now coming to be generally recognized that welding is successfully done only with an equipment that permits close heat adjustment, and which is sufficiently workwise as to permit proper manipulation of the arc by a competent operator. The first requirement (the heat adjustment) is comparatively easily met. The second requirement (a workwise arc) is not so easily met if efficiency and weight are to be considered. Opinions at the present time are almost unanimous in favor of the variable voltage type of welding equipment. As to the regulating characteristics, there are some variable voltage equipments which tend to maintain a constant heat within a certain voltage range while others tend to maintain a constant current within a certain voltage range, usually between 15 and 25 volts. Both types are in successful use and up until the present time there has been no conclusive evidence to show any marked advantage of one over the other. There are other types of welding equipments in successful use, all of which have their advocates. A description of the different types of equipments in use, will appear in the next article.

AMERICAN WELDING SOCIETY ORGANIZED

An association known as the American Welding Society was organized at the Engineering Societies building, New York, March 28, 1919 This society will merge the welding committee of the gency Fleet Corporation and the National Welding Council, and its purpose is to provide a disinterested and dependable source of information on welding, not only for the benefit of the manufacturers of welding apparatus and supplies, but also to aid those who use welding in their production and those who purchase welded goods. The society will bring together in the manner usual for scientific societies persons from all branches of the industry, who may be interested in any of the welding processes. It is proposed that the society will create and assist in maintaining a Bureau of Welding which will be a separate organization designed to take advantage of the principle of co-operation in research and standardization. The American Bureau of Welding consists of a joint board of directors, 30 from the American Welding Society and one each from the various scientific and engineering societies, including the American Railway Association, and one each from the United States Commerce, Navy and War Departments and the United States Shipping Board.

Membership in the American Welding Society is divided into five classes: Class A, sustaining members, annual dues $100; open to one or more representatives from each corporation interested. Class B, annual dues $20; open to individuals who may or may not be employed by corporations, and to consulting engineers, college professors, etc. Class C, annual dues $10; open to members of existing societies which will become affiliated with the new society through the proposed Bureau of Welding. Class D, annual dues $5; open to welding artisans. Class E, open to trade associations, putting them in the same category as corporations. Class F, honorary members. Class C and D memberships do not carry the privilege of voting or holding office.

A large number of corporations and engineers are interested in the project, including officers and members of many of the national technical and engineering societies, universities and engineering schools, government departments and bureaus, gas and electric welding companies, and shipbuilding, steel and automobile companies.

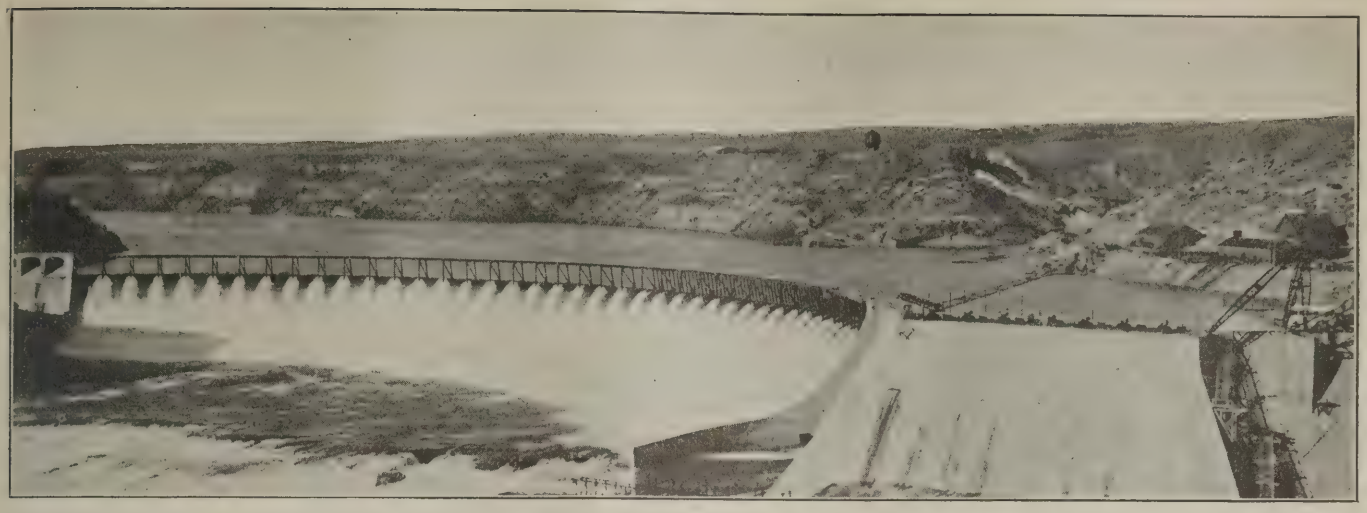
The following officers were elected:

President—C. A. Adams, President, American Institute of Electrical Engineers, Cambridge, Mass.
Vice-President (for 1 year)—J. M. Moorehead, Union Carbide Company, New York.
Vice-President (for 2 years)—C. L. Brunner, Brunner Manufacturing Company, Utica, N. Y.
Directors for 1 year:
W. M. Beard, Linde Air Products Company, New York.
M. H. Roberts, Air Reduction Sales Company, New York.
M. M. Smith, Commercial Acetylene Company, New York.
L. D. Lovekin, American International Ship Building Corp., Philadelphia, Pa.
Alexander Churchward, Wilson Welders and Metal Company, New York.
W. H. Patterson, Westinghouse Electric & Mfg. Company, Pittsburgh, Pa.
Walter J. Jones, Chester Shipbuilding Company, Philadelphia, Pa.
C. A. McCune, Page Steel & Wire Company, New York.
Directors for 2 years:
R. R. Browning, Oxweld & Acetylene Company, New York.
A. S. Kinsey, Professor of Experimental Mechanics, Stevens Institute, New Jersey, N. J.
Victor Mauck, John Wood Manufacturing Company, Conshohocken, Pa.
E. L. Hirt, Bethlehem Shipbuilding Corporation, South Bethlehem, Pa.
J. F. Lincoln, Lincoln Electric Company, Cleveland, Ohio.
H. M. Hobart, General Electric Company, Schenectady, N. Y.
D. C. Alexander, Quasi Arc Weldtrode Company, New York.
H. R. Swartley, Jr., Davis-Bournonville Company, Jersey City, N. J.
Directors for 3 years:
L. H. Davis, Linde Air Products Company, New York.
E. L. Mills, Air Reduction Sales Company, New York.
D. B. Rushmore, General Electric Company, Schenectady, N. Y.
James Burke, Burke Electric Company, Erie, Pa.
D. H. Wilson, Jr., Wilson Welders & Metal Company, New York.
Hermann Lemp, General Electric Company, Erie, Pa.
C. J. Nyquist, Torchweld Company, Chicago, Ill.
Alexander Jenkins, Alexander Milburn Company, Baltimore, Md.

It was voted that the charter should be held open for ten days and that those applying for membership in the American Welding Society before April 8, should be considered charter members. By a unanimous vote Prof. Elihu Thompson was elected first honorary member.

At a meeting of the directors in the afternoon, W. E. Symons, Galena Signal Oil Company, Franklin, Pa., was appointed Treasurer and H. C. Forbes, Consulting Engineer, New York City, Secretary.

Rapid Cooling of Hot Metals hardens them, but the General Electric Company has demonstrated the opposite by annealing American ingot iron surrounded by hydrogen gas for three hours at a temperature of 1,600 deg. F. The product was very little harder than the softest copper and could be whittled with a knife.



Great Falls Dam at Volta; Chicago, Milwaukee & St. Paul Electrification

The Real Problem of Railway Electrification*

Exponents of Electrification Are Learning to See With the Eyes of the Railroad Man

By Calvert Townley

ELECTRICITY now performs every railroad service previously rendered exclusively by steam locomotives and in every case does it better than it was done before. But in order to use electricity a large investment in equipment and installation must be made and electrification has proceeded slowly because railroad executives were not convinced that the advantages to be gained are always worth the cost.

The progress of electrification has also been impeded, first, before the war by the difficulty in financing, due to conditions other than the merits of electrification, and second, since the war began, because every one has been too busy to consider any work that could be deferred and because the government's taking over the railroads has created an unsettled situation not conducive to the investment of new capital for future returns. Now, however, there seems to be ground for hoping that these bars to progress will be removed in the not distant future so that electrification can be again studied on its merits, therefore our consideration of the subject is timely.

In reviewing the past twenty years' history of this question, I cannot escape the conclusion that we electrical men, and not our steam road colleagues, are responsible for the slow progress made. We have not known enough about either the science or the art of railroading. Our belief in, and our zeal for our own profession has led us, albeit with entire honesty of purpose, to make more or less extravagant claims as to what we could do and to underestimate the cost of doing it. The inevitable reaction of mind which followed an accurate determination of facts of course disturbed confidence in our judgment. But if at times we have injured the cause of electrification by claiming too much, strange as it may sound, we have injured it a great deal more by not claiming enough.

Electrical engineers not having always been railroad men have been unable to study railroad problems as they should have been studied, that is to say, with only real and not with any arbitrary limitations before them. It has been natural for the electrical man to ask the railroad man for a statement of the conditions he was expected to meet. It was equally natural for the railroad man to prescribe the conditions upon which his steam service was predicated. Under these circumstances the problem became largely one of replacing one sort of locomotive with another, and of balancing hoped-for economies in operation and maintenance on the one hand, against fixed charges for the additional investment required, on the other. Right there comes the mistake. A perfectly natural but a fundamental mistake, for which no individual or class should be censured but for which the unusual development of the art is responsible. We cannot blame railroad men for not being electrical engineers nor electrical engineers because they are not railroad men, but the progress of electrification has had to lag until both should be able to see, each with the eyes of both. It is only by combining the railroad man's knowledge of the fundamental requirements of his service with the electrical man's skill in applying electricity to perform that service that all the possibilities of any specific problem may be developed.

The electrification of a railroad is not simply the substitution of one kind of locomotive for another. It is far more than that. It is the adoption of a fundamentally different method of train propulsion. It is conservative to say that, within the bounds of ordinary practice, electricity can furnish every train with all the pulling power that can be used. The limitations of the steam locomotive in this respect disappear and ruling grades rule no longer. A strictly limited motive power is replaced by one that is practically unlimited.

* A paper presented at the 348th meeting of the American Institute of Electrical Engineers, Boston, Mass., March 14, 1919. Copyright, 1919, by A. I. E. E.

Kind of Equipment Not Important

There are a number of so-called "systems" of electric traction and heavy emphasis has been laid by the advocates of each upon its points of difference from every other. So much has been said about these differences and so little about the points of similarity as to create an entirely misleading impression. It is a fact that there are more kinds and types of steam locomotives in use many times over than there are electric systems. It is a fact that except for the storage battery locomotive, which has but a limited field of application, all electric systems have many more common features than differences. It is a fact that they agree on fundamentals and differ in detail only. Their costs may not be the same, their efficiencies may vary, but they all do their work and do it successfully and well. The possibility of unlimited electric power is a characteristic not of any one system but of all. It is due to basic differences between steam and electric equipment. A steam locomotive is a complete independent unit which not only generates, but also utilizes its power. The electric locomotive generates no power at all. It is only a translating device receiving energy from an outside and a remote source. The electric power house always having much greater capacity than any one locomotive, can supply ample power for the heaviest train on the steepest grade. The steam locomotive, which carries its own power house with it, is limited to the capacity of its one boiler. By the multiple unit principle, as many electric locomotives as may be needed can be coupled together and operated in synchronism by one crew from any cab. Any required tractive effort can thus be exerted without slipping the wheels, without imposing undue strains on the rails or bridges and without increasing the number of engine crews.

Track Capacity Is Increased

The business of a railroad is to transport freight and passengers. I put freight first because on the average it produces 73 per cent of the revenue. Unlimited motive power permits longer trains and higher schedule speeds. On the Elkhorn grade of the Norfolk & Western the schedule speed was doubled. It cuts the operating cost by hauling more cars with the same or a smaller crew. The Norfolk & Western uses two electrics to do the work of three Mallets. These new opportunities at one fell swoop banish many of the railroad's time honored traditions. The traffic possibilities must be studied from a new angle and advantage taken of every facility. It is a new thought to realize that train length is limited not by motive power, but by the yard tracks and length of sidings, or that all the trailing tonnage that the draw bars will stand can be hauled. Nor are these new limits fundamental. Sidings can be extended, draw bars can be made stronger, if it pays to do it. In a word electrification opens up tremendous possibilities of increasing the freight capacity of a road and without it being necessary to build additional tracks.

Aerial Rights Made Valuable

While not as important as freight, passenger traffic likewise comes in for its share in the widened horizon and the vanishing tradition. Unlimited power of course is available, but the absence of combustion is another basic advantage. Smoke and cinders disappear. Tunnel operation loses its terrors. Unobscured signals permit normal speeds with undiminished safety. Projects like the Pennsylvania terminal in New York, depending entirely on submarine tunnel operation and previously impracticable, become immediately possible. Railroads owning valuable realty in cities can erect buildings thereon, where before smoky locomotives made any structure above the ground level impracticable. The aerial rights are now valuable. Multiple unit operation has in fact made suburban traffic. The rapid acceleration made possible by electric traction has directed attention to the equal value of rapid retardation and has quickened the study of braking accordingly; also of modified coach design to bring about the more efficient loading and discharge of passengers. These combined possibilities secure increased schedule speeds and attract patronage. The people not only get over the line in a shorter time, but as a corollary more people get over it in the same time. Again it is seen therefore that in passenger as in freight traffic the ability to do something that could not be done before, rather than to do the same thing at a lower cost, is the most valuable attribute of electrification, and again we find a greatly augmented capacity without the need of additional tracks.

It is not my purpose to make an exhaustive comparison of the relative advantages of steam and electric operation. That has been done often and well by others. What I have said about the expanding opportunities for electrified service is by way of illustration to emphasize my plea that the question should always be viewed in its broader aspect and not hampered and restricted within any narrower limitations than properly belong to it.

Complete Electrification of All Roads Impossible

I am going to assume, then, the broadest possible treatment and to suppose that every electrification project is to have its pros and cons most fully examined. The real and vital question then is, "How far will this lead us?" "To what extent may we expect complete electrification of all our roads?" Parts of a number of them have already been equipped. Many of these are numbered among our prominent roads, successful corporations which have had the advice of the most highly skilled executives and engineers, and which are progressive. The service performed on the electrified sections comprises practically every kind of railroad transportation. The Bluefield division of the Norfolk & Western in West Virginia is an example of an important coal road operating through the mountains. The Chicago, Milwaukee & St. Paul 440-mile main line, through Idaho and Montana, demonstrates what can be done by a transcontinental carrier on a large scale with through traffic, both freight and passenger. The New York, New Haven & Hartford 73-mile stretch between New York and New Haven shows how through freight and a heavy passenger traffic can be taken care of on the most congested four track section of an important eastern carrier and what is possible for complicated freight yard operation, while the New York Central and the Pennsylvania out of New York City are splendid examples of our greatest modern passenger terminal electrifications. There are, of course, many other electrifications, but even if there were not, those named are of a character to command the respect and attention of the railroad world. Now, every one of these projects has been successful. Every one has justified itself. Nearly every

one in its present scope represents an extension of the zone initially electrified, the most convincing evidence possible as to what views the operating companies hold regarding these several projects. Railroad officials are generally glad to give others the benefit of their experience, so it is reasonably safe to say that operating statistics are available covering long enough periods so that the results to be expected from any proposed undertakings may be predicated on established facts and not upon theories. In the light of present day knowledge, therefore, what answer can we make to the question, "Should all railroads be electrified?"

Taken together, in 1910 there were in the United States 240,000 miles of railroad main line regardless of the number of tracks. Of this mileage approximately 1,250, or one-half of one per cent, has been electrified or is today in process. The remaining 99½ per cent comprises, of course, roads performing every variety of service. They range from the back country branch line built by some over-enthusiastic promoter and now perhaps operated as part of a large system, only because operation cannot be avoided and regularly contributing its annual deficit, up to the most important through arteries of travel upon which the commerce and industry of the nation depend. Every sort of community is served; every kind of railroading has its place in this vast aggregation of effort and the variables in the problem are so multitudinous and their nature often so profound as to well daunt the courage of one who seeks to formulate them for incorporation in a general statement.

Fortunately or unfortunately, depending on the point of view, it has been my lot to have to deal with the electrification problem from both sides. At one period from the standpoint of an intimate affiliation with the development and manufacture of electrical apparatus and at another from that of one charged with official responsibility on the railroad's behalf. I am a thorough believer in the virtues of electrification and an enthusiast about the wonders which it can accomplish, but I also have a keen appreciation of the almost infinite variations in the railroad problem and a very wholesome respect for the dollar. I do not believe that all railroads will ever be electrified. I am not sanguine even that all the tracks of any one really big system will be so equipped in our time. It is a question of economics, and the results will not justify the expenditures even when considered with such broad vision as that which guided the Pennsylvania in spending millions to put their passenger terminal in New York City without the prospect of a direct return. Electrification will increase the track capacity. But there are thousands of miles of railroad that have sufficient capacity now, frequently several times over, and where the wildest stretch of imagination fails to picture a future need of this kind. Electrification works wonders in suburban and interurban passenger service. I have ridden for hours across the western prairies without seeing a single town, much less a city where these advantages would count. Electrification effects marked economies in fuel, in maintenance, in labor and otherwise through a long list; but electrification calls for a heavy investment and unless these economies bulk large enough, the interest on such investment will wipe them out and turn the enterprise into a losing venture. I do not believe the cause of electrification is helped by undue optimism on the part of its advocates. Rather should there be an enlightened partisanship, enthusiastic where enthusiasm is justified, but tinged with the sober conservatism of the man who has to put his own dollars to work.

Plenty of Work for Engineers

There need be no discouragement to the electrical engineer in the views just given, nor to the railroad man who has looked toward the new motive power for salvation. There are so many cases where electricity should be used, where its advantages are clear and conclusive, that once the railroads escape from the financial slough of despond in which they are now wallowing and are again able to get capital for their needs, there will not be enough engineers, there will not be enough electric factories in the country to serve them. Every big system has need of electricity somewhere. For some small roads it may mean the difference between solvency and bankruptcy. I electrified a short derelict line for the New Haven Road between Meriden and Middletown, long before given over into the one-train-a-day-annual-deficit class, and turned it into a good earner.

There can be no rule established. Generalities are sure to be misleading, but electrification is now firmly intrenched and successful. It is recognized by railroads generally as an effective agency with great possibilities and one which is particularly valuable for certain specific purposes. Time alone will tell how broad its application is to be, but I am confident we can await developments with tranquility assured that the art is in a healthy condition and that progress will be along the right lines.

Discussion

The paper was discussed by representatives of the General Electric Company, the Westinghouse Electric & Manufacturing Company, and a number of men representing railroads in the United States and Canada. All of those discussing the paper heartily endorsed Mr. Townley's attitude toward the problem and W. F. Murray of the Connecticut Light & Power Company outlined a plan for electrifying a large section, including lines on six eastern railroads. This plan has been given serious consideration at Washington. The substance of Mr. Murray's discussion was as follows:

Plan for Electrification Proposed

We must not selfishly think of the electrification of one or two large roads. It is very true that we may reap a great money interest from that electrification, but it seems to me that this is not the right way to go after this matter. We must, if we are going to make electrification a success in this country, get after many roads, and we must do that on a district basis. In 1914, I had the pleasure of discussing with one of our prominent electrical engineers a plan for electrification which I think will appeal to you. It involved six roads, Hudson River, Lehigh Valley, Central New Jersey, West Shore, Erie and Pennsylvania.

It seems to me that there was at that time a magnificent opportunity of what may have been called the formation of a power and equipment company with the idea in mind that a standard equipment be used on these railroads for service in the metropolitan districts, for freight service and for switching service in the large terminal yards in that section and for the distribution

of power to that district for those railroads. At that time the railroads were tremendously embarrassed, as they are now, in the matter of finances. Yet if a standard equipment could be produced, the finances could be taken from the embarrassed railroad hands and smoothed out by bankers, who would have jumped at the opportunity, and taken care of the purchase and equipment. Of course, the power house which would furnish the power would be compensated for by their contract for power and such profits as they would make would easily put them in a position for the bankers to finance these buildings. The shifts that would be necessary to take care of this equipment could also be taken care of in a financial scheme, and so the proposition could be financed. In fact, I have discussed the matter with several people in New York, who were very much interested in it, and it seemed that a serious consideration would be possible when the war broke out in 1914. Naturally, it was then impossible to talk of these things.

Government's Investigation for Transmission Line

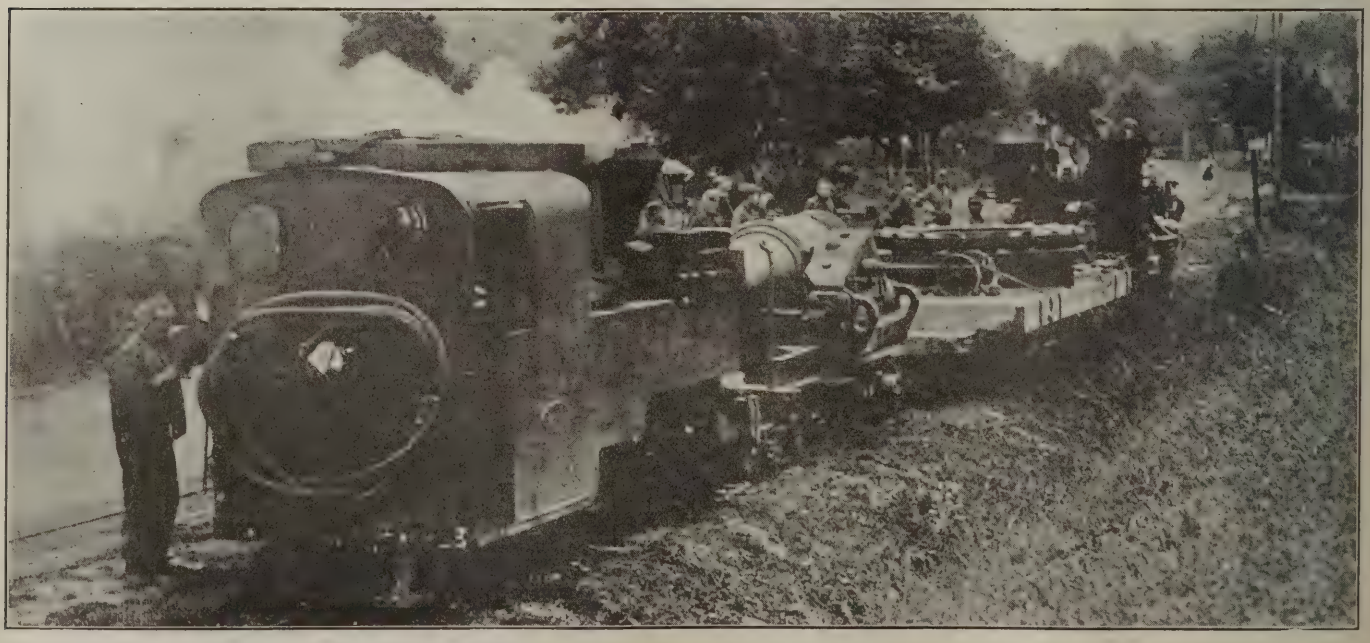
We have been doing a very wonderful work for the government in connection with the investigation of a superior 150,000 volt power transmission line which would extend from Boston to Washington. The opportunity offered itself for development of large power stations at the mouths of mines, tidewater steam stations and water power stations. Into this transmission trunk line system, therefore, would be fed this highly economic power. You might say right away "what would be the advantage of such a line, and could we not, on account of the very large stations we have developed, produce power as economically, and therefore why go to the expense of a superior power transmission line?"

Our investigations show that with units of from 25,000 to 40,000 kw. we can safely figure on being able to produce a kw. hr. with something between ten and fifteen pounds of steam, and be sure of it. I venture to say that in the district between Boston and Washington the amount of steam required to produce a kw. hr. as applied to the railroads and to the factories, will average 25 to 30 pounds, and consequently there is offered an enormous saving in production. This, however, is not to pre-empt any stations in central districts that are merely contributing their quota.

This was seriously considered in Washington, and I do not know but what you may have all noticed in the papers the plan which Secretary Lane has proposed which comprehends practically what I have tried to describe. There was submitted through the secretary-treasurer to the Appropriation Committee of the Senate a bill calling for the investigation of this matter—a bill reading "This amount of money to be appropriated for the investigation of the economies to be obtained by a power generation and transmission system covering the district between Boston and Washington." On account of the great number of bills being held up in Congress, this, together with others, has been laid over, but it is to be hoped that the new Congress will appropriate a sufficient amount of funds to make this investigation.

I want to leave with you this thought. In discussing this matter of a superior power line with a number of engineers, I have not found a single dissenting voice. Someone may say that the idea is all imagination, but that is wrong. I must confess there is imagination in it: I think the man who has no imagination needs a guardian. Let us admit that there is some imagination. You must imagine a patent before you can make it. I claim that the scheme is practical. There is nothing in it that is impractical. Let us make the investigation and find out.

Do not let us get behind England, who is doing just this thing. We have as much area in this regional district as England has. If we have got to compete with the world's markets and maintain a world standard, we must have some superior scheme by which these powers can be made and used.



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Train Drawing Two 310mm. Trench Mortars

Railroad Electrification Facts and Factors

Operating Conditions Determine the Important Construction Details of the Pantagraph

By A. J. Manson*

WE pointed out, in the preceding article that electric locomotives can be classified under two headings according to the method employed in the collection of current,—first, those equipped with pantagraphs to collect the current at high voltages from overhead wires located several feet above and directly over the track and second, those equipped with third rail shoes to collect the current from conductors located along side of and adjacent to the running rails. The collection of the electric power for operating the locomotive is most interesting so that we will now take up and discuss in detail the design and manufacture of the apparatus used under both of the above headings.

First, we will consider the pantagraph collector. As the single phase high voltage system used the overhead wire prior to the high voltage direct current system, the type of pantagraph for this service will be considered in advance of the type for the high voltage direct current.

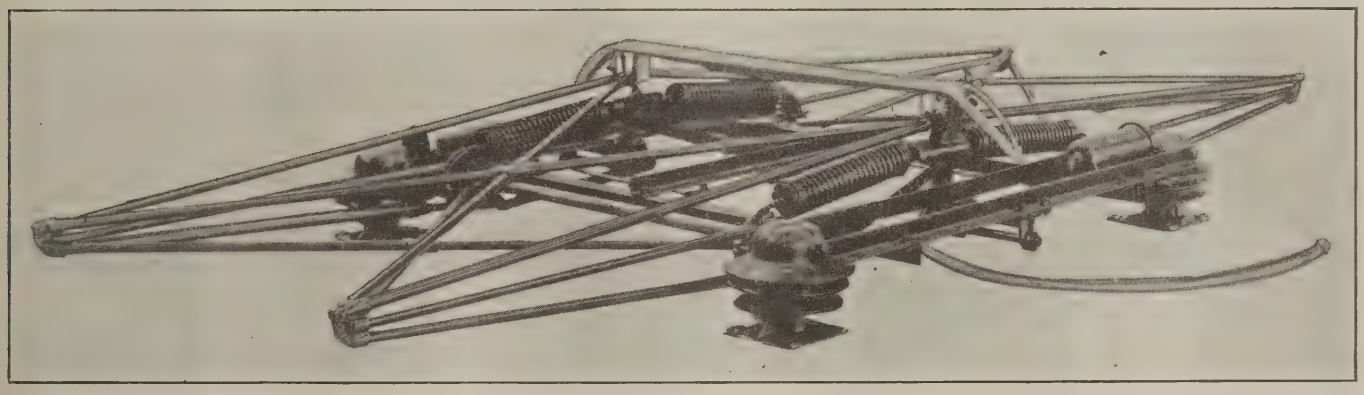


Fig. 1—Standard Pantagraph Frame Fitted With a Flexible Shoe for High Speed Service and for the Collection of Power at 11,000 Volts in the "Down" or "Lock" Position

Obviously, some difference would be expected between the two types. The high voltage alternating current collector does not need to handle comparatively large currents on account of the high voltage—say of 11,000 volts, even when large amounts of power are collected. While the high voltage direct current of 3,000 volts is a high voltage for direct current, it is only approximately one-fourth of the alternating current voltage, so that for the same power the current collected will be nearly four times that for the single phase system. The collection of the current required for the large locomotive units has been a good problem, but it has been nicely solved, as will be brought out further on.

In the preceding issue, clearance diagrams for overhead conductors, as recommended by the American Electric Railway Association, were given. These diagrams showed heights from 16 ft. 10 in. to 25 ft. Overhead wires on a large system may be anywhere between these limits. Normally the wire will be kept at 22 ft. to 24 ft. but due to overhead bridges or other causes the wires will have to be lowered, and then brought back to the standard height as soon as obstructions, etc., are passed.

The pantagraph must then be so built that it will work satisfactorily between these limits and must remain in continuous contact with the overhead wire. It must be as light as strength will allow, so as to reduce inertia to a minimum and enable the shoe of the pantagraph to keep in contact with the wire at all times and at high speeds. The pantagraph must be strong as it is subjected to considerable strain. Take for instance a pantagraph mounted on a passenger locomotive running at 60 to 70 miles an hour. With the wire at normal height the shoe of the pantagraph is 8 to 10 feet above the roof of the locomotive. The rocking and the swaying of the locomotive is transmitted to the pantagraph and it must be strong enough to withstand this lateral sway which is at great leverage. It must also be strong enough to withstand the blows received at "special work" in the trolley wire on account of cross-overs, sidings, etc., and to withstand the sudden pressures due to the wire passing under overhead bridges, etc. The grade or slope of the wire, when passing under overhead bridges should not be too steep—preferably not more than 1 per cent. Too great a slope will cause considerable pressure to be exerted on the shoe and frame of the pantagraph when operating at high speeds. The pantagraph would have to be strengthened, resulting in more weight, which is a disadvantage. Some idea of the blow exerted can be formed when it is considered that at 60 miles per hour the speed is 88 feet per second and if the slope of the wire was say 3 per cent the pantagraph would be pushed down nearly 3 feet in a second. To keep the shoe in contact a pressure of approximately twelve pounds against the wire has been found to be best. Due to the friction of the various parts and bearings of the pantagraph, the pressure to push it down will be approximately 17 lb. to 20 lb. This is the pressure when pushed down slowly, but when pushed at the rate of 3 ft. per second the inertia enters into consideration and the pressure will be very much higher.

*Westinghouse Electric & Manufacturing Company, New York.

In general appearance, all pantagraphs are alike and in fact there is very little difference except in details of shoe design and in methods employed to keep the pantagraph against the wire. The same frame and practically the same raising and lowering sections or parts could be used whether the pantagraph is used on a high speed passenger or a freight locomotive with single phase 11000 volt current supply, or in connection with the collection of current from the high voltage direct current overhead wire at 3000 volts. It is, however, necessary to consider the shoe details for the different types of locomotives and for the different systems.

For high speed service it is very important to have the shoe flexibly supported to the main framework of the pantagraph so that it will respond to the slight irregularities in the trolley thereby eliminating sparking. Constant contact is maintained which would not exist without this feature. The shoe itself is of small mass compared to the whole pantagraph frame so that while the flexibly supported shoe will quickly adjust itself to the irregularities, the frame will not respond, due to its inertia. Without this flexibility sparking would occur.

A standard pantagraph frame fitted with a flexible shoe for high speed service and for the collection of the

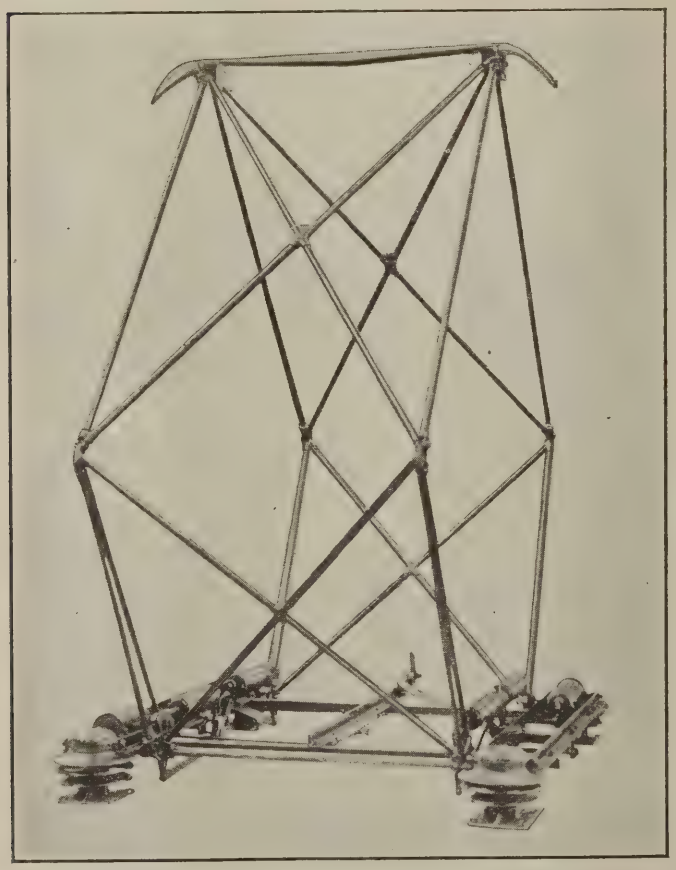


Fig. 2—The Same Pantagraph as Shown in Fig. 1 in the Raised Position. As Shown Here It Is at Its Maximum Height

power at 11000 volts is shown by the photographs Fig. 1 and Fig. 2—the first showing the pantagraph in its "Down" or "Lock" position and the second showing it near its maximum height. The complete pantagraph consists of a base made up of angle iron, mounted on four insulators. The insulators are mounted on steel pins having wide bases which are bolted to the roof of the locomotive. Some installations have these four insulators bolted to a frame which is insulated from the roof of the locomotive, so that between the 11000 volts and ground there are two insulators in series giving double insulation. The detail design of this high voltage insulator is shown by Fig. 3. An iron cap *A* with an outside diameter greater than the porcelain petticoats forms the top part of the insulator. An insulator on top of a locomotive is subjected to damage from external sources and one of the petticoat type especially should be protected. As shown in the photographs, the angle iron base is bolted to the iron cap. Some form of cap cemented to the insulator is necessary, and it is an easy matter to design one with a flange to protect the porcelain. Between the

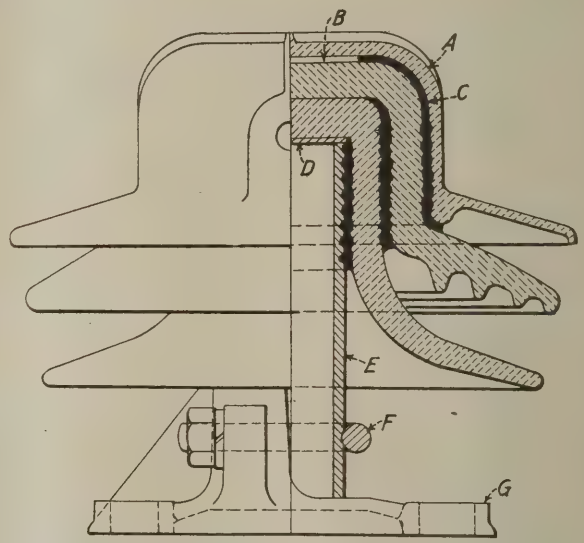


Fig. 3—Detail Design of One of the High Voltage Insulators Used to Support the Pantagraph Frame

steel cap and the first porcelain is placed a lead washer or disc *B* 2⅞ in. in diameter to form a cushion and to prevent breakages while assembling. Also sufficient space is formed so that the rest of the space is filled by cement *C* and the steel cap does not come into contact with the porcelain. Between the second petticoat and the steel pin *E* there is placed a steel disc *D* 2½ in. in diameter. The pin is fastened to the insulator base *G* by the U-bolt *F*. This particular type of insulator is rugged and moreover has a very high factor of electrical safety.

The framework consists of four movable members, two upper and two lower. The two upper members are hinged together at the top. The lower end of each lower frame is clamped securely to a casting which is pinned to the cross shaft of which there are two parallel to each other. The casting to which the frame is clamped also includes the cam over which passes the chain from the spring. It should be noted that this cam is not circular but is of irregular shape. The curvature is determined from calculations and tests, and is so designed that the shoe will exert a fairly uniform pressure throughout the operating range of the pantagraph but will increase near the down or locked position, so that when the pantagraph latch is unlocked or released, the trolley will start to rise promptly and quickly, and when lowered the increase in pressure will tend to cushion it. The upper and lower frames are joined together by hinged joints. The details of the frame construction are shown in Fig. 4. Pantagraphs for operation at 60 miles per hour have the tubes made from high carbon steel. The frames are

cross-braced to give lateral stability. The side members *A* are subjected to bending strains so that these members are built up of two tubes one inside of the other as shown in Fig. 4.

The first pantagraph trolleys had horizontal cross members so that each frame section was rectangular in shape. With these horizontal cross members eliminated, more space is available on the roof of the locomotive without sacrifice to the strength and stability of the pantagraph.

The pantagraph trolley illustrated by Fig. 1 and 2 is of the most common type in that it is spring raised and lowered by air pressure. The springs are shown consisting of two sets of two each and work under tension. The rotating force on the two parallel shafts tending to

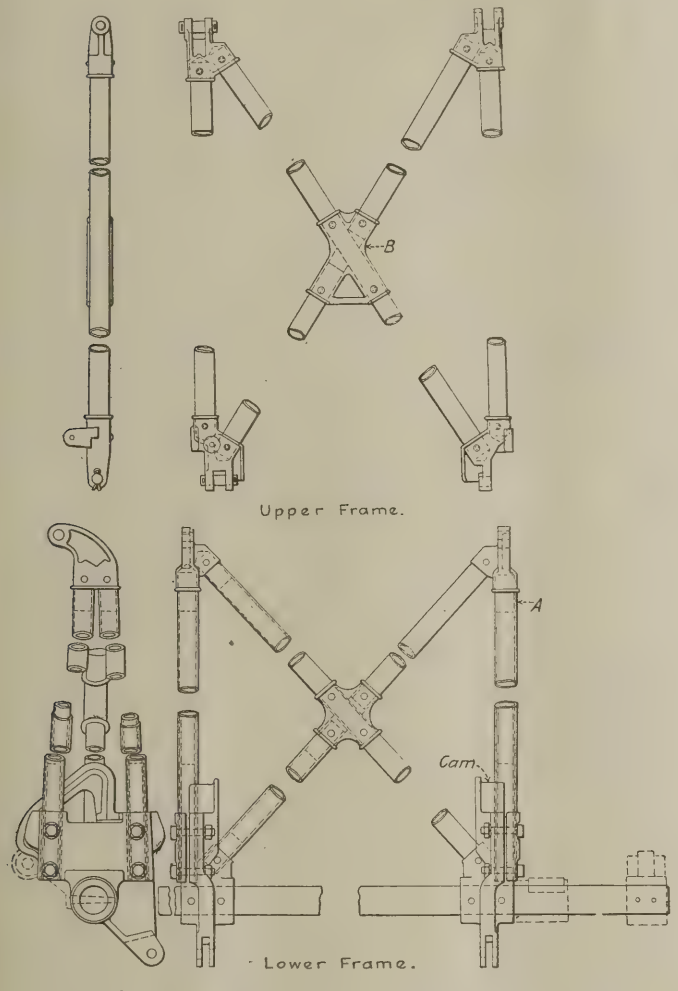


Fig. 4—Detail Construction of the Pantagraph Frames

raise the frame, is transmitted from the springs through the chains and cams to the shafts.

Air pressure is used to lower the pantagraph and the reverse rotation of the shafts is accomplished by levers and links connected to two air pistons—one located on either side as shown. The links can also be seen.

The details of the piston are shown by Fig. 5. The cast iron cylinder *A* is tapped for air connection as shown. The end of piston *B* pushes against the lever, *C*, the other end of which connects to the links running to the levers on the shafts. The piston is limited in travel by the lever coming up against the cylinder cover *D*. A form of piston leather is used similar in design to the piston leathers of air operated multiple unit control switches. The piston *B* is slightly cupped so as to fit the leathers which are formed cup shaped. The completed piston leather *E* is 3-ply, each separate but formed together. Between the leather and the cast iron washer *F* is placed the piston leather expander *G*.

When the pantagraph trolley is lowered, it is held in the "down" position by means of a latch which catches over the cross casting *B* of the upper frame (Fig. 4). The latch is unlocked by air, releasing the pantagraph

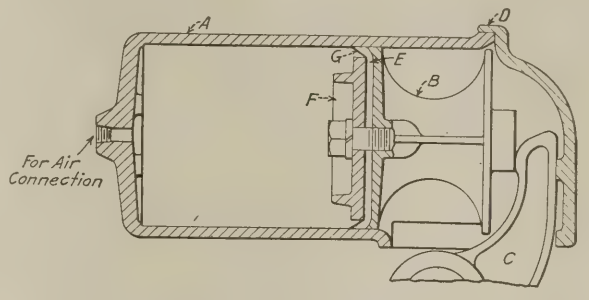


Fig. 5—Sectional Drawing of Air Cylinder Used in Lowering the Pantagraph.

which is carried up by the springs. The details of the complete latch are shown by Fig. 6. It consists of a cylinder *A*, latch *B*, piston rod *C*, retaining plate *D*, piston leather *E* of same general construction with follower and expander as in the air cylinder and spring *F*.

The above description of the pantagraph trolley has covered all of the main parts with the exception of the

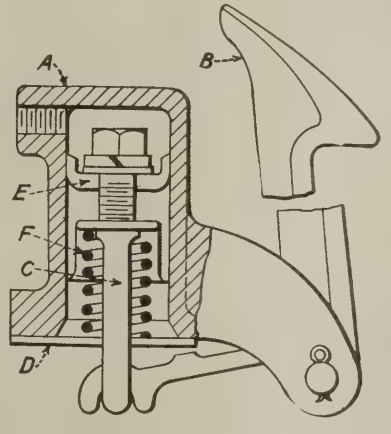


Fig. 6—Detail Sketch of Air Chamber and Catch Used to Release the Pantagraph from the "Down" or "Locked" Position

shoe. This item will be taken up in the next issue. Various types will be discussed and information will be given as to the current collection ratings and the kinds of service in which each type can be used.

The United States Supreme Court on Monday affirmed a decision of the Court of Claims sustaining a claim of the Union Pacific for payment for the transportation of discharged, retired or furloughed soldiers, military prisoners and applicants for army enlistments at the usual rates of fare. The case arose before the period of government control. The decision holds that such men are not troops entitled to reduced rate on land grant railroads.

Trials and Troubles of a Car Lighting Man

Hinkey Dee Finds That Belt Slipping Can Be Stopped But That Unexpected Results May Follow

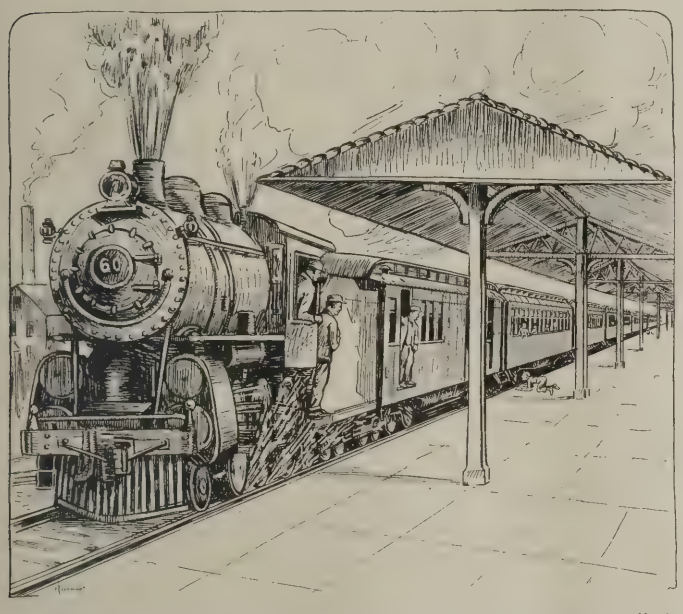
RAIN! Rain! Beautiful rain! If there's anythin' in this wide world that us car lightin' fellers like to see and crave for more than rain, I'd like to know what it is. It was a most beautiful day—yes, it poured rain all day. The rain was wet, the ground was wet, the cars were wet, the cables were wet, and I was wet. Every time I'd pick up a cable with my wet gloves to plug a car on charge I'd think my arm was coming off. Oh, Boy, how it would jar you! Why I got so many shocks that day that I was afraid to eat with a knife and fork for fear I'd get short circuited in some way. A fellow sitting in a car watching me plugging on cars, saw me jump so many times, he raised the window and asked me if I was a drinking man or if I had the St. Vitus dance. I told him that I was Hinkey Dee, the electrical expert, and I didn't drink and that I wasn't dancin' either. It sure does get me goat when some no-nothin' like that butts in and makes fun of you when you knows all about what your doin'. Just as if I could help a-jumpin' when I got a shock. But I didn't care about anythin', I just worked all day with a bunch of confidence because I just knowed that car-lightin' was a kind of second human nature to me and that I was good at it. So I says to meself, "Hinkey Dee, you've got the right stuff in you and your goin' to keep pluggin' ahead no matter if it rains so many shocks that you shake your head off." Jimmy Goat saw me jump several times and he laughed like a fool at me. My! how I do hate to have any flathead like that laugh at me. I set me meter down on the ground between the tracks to leave it there while I plugged a car on charge, and when I turned around to pick it up, it was gone. I hunted and hunted and hunted to find the feller that took me meter but couldn't find him. The next day Jimmy Goat found me meter right where I had left it the day before, stickin' out of a puddle of water. I tried to explain to the boss that it wasn't my fault that I just set the meter down and turned around to plug the car and when I turned again me meter was gone, the rain must have formed into a puddle and covered the meter. The boss got mad and told me the next time not to work so fast and maybe they'd find me in a puddle of water somewheres. Jimmy Goat heard the boss a-ballin' me out and had a good laugh, but the next day I had the laugh on him. He threw his meter out of the car window in mistake for an empty lamp box, just as me and the boss was a-passin'. I ducked and the meter landed square on the boss' head. Fortunately, the boss had a soft hat on and caught the meter before it struck the ground. Jimmy mostly threw a fit and told the boss he was sorry and it was all an accident. The boss looked at Jimmy like a wild man and said, "Jimmy Goat, if I didn't know you so well I'd ball you out, but, what's the use!" Now wouldn't that jar you! That feller, Jimmy Goat, I believe could get away with murder. Well, I made up my mind that I'd take care of me meter and leave no more meters on the ground to be flooded over. So I set it in the car on the seat instead, and talk about dumb luck. Well, to tell a long story short, the car was pulled away with my meter on the seat while I was lookin' for a cable to put the car on charge and wasn't found for nine days. A car inspector at a small country town found it. He had it turned over to the County Squire and they both agreed that it was some sort of an infernal machine,

He Threw His Meter Out of the Car Window in Mistake for an Empty Lamp Box, Just as Me and the Boss Was Passin'

set to go off at some definite time, so they placed it in the center of a big field and started out to search for the owner. The boss 'phoned around aud finally located the meter, but if the Squire had had his way I guess my toes would have been facin' the daisies long ago. The boss said if he was me he'd go out to the Zoo and watch the snails whizzing by, and if I didn't stop losing volt-meters he was agoin' to tie one around me neck.

The followin' day a car arrived in train No. 16 with the lights in trouble and the boss told me to ride with the car and see if I couldn't fix it. Before the car left, Jimmy Goat came around and told me he thought the trouble was in an arm on the thing in the closet inside the car. He said he thought if I'd work the arm up and

down that everything would be all right, and that the lights would lit. I learned afterwards that the arm he put me wise to was called the lamp regulator arm. The train started and I moved the arm up and down as fast as I could, but it didn't seem to fix the lights. I thought for a minute and said to meself, "Hinkey Dee, Jimmy Goat said to work the arm, now's your chance to work the arm so's to fix the lights and make a name for yourself." Well, believe me or not, I worked that there arm up and down until I was blue in the face, yes, I worked that there arm up and down until noon the next day, didn't even stop to eat, but I still couldn't get the lights



Finally the passengers were all aboard and the conductor pulled the whistle to start, but the old engine couldn't get the train started, no, it simply couldn't move the train an inch.

fixed in the car. Then I decided to give it up and go back to where I had started. As I was leaving the car I saw the strangest looking thing under the car. It had a wheel on it and a kind of flat rope or sheet rubber on it. Yes, I guess it was some kind of a belt. When I returned I explained to the boss that I couldn't find anythin' and that I didn't think there was anythin' much wrong with the lights. He asked, "What did you do, Hinkey?" I told him that I had worked that there arm that Jimmy Goat showed me up and down every minute from the time I left until I returned. The boss smiled, that seemed awfully funny to him, but I didn't get the joke. Then I asked him what that there thing was fastened under the car that had a wheel on it and a belt. Then's when he did heat up, he got so mad he nearly collapsed. When he collected himself again he told me I was the wisest man he ever met. Then I realized that there was a mistake and that there was somethin' about car lightin' that I really didn't understand. So I asked Jimmy Goat and he told me all about the thing under the car. He told me all about the wheel on this thing going round when the car moved and all. He said that the most trouble was with the belts. That the belt would slip and when the belt slipped the thing under the car with a wheel on it wouldn't work. He said some belts would slip no matter what you did to them, and that no man so far had been able to stop it. I said, "Jimmy, do you mean to say that nothing is known that would stop them belts from a-slippin'?" He said, "Yes, sir, Hinkey Dee, that's what I said." Then I thought to meself, "Hinkey Dee, here's your chance to show that you are full of brains and gray matter. Just invent somethin' that will stop those belts from slippin' and your fortune is made." I set up nights and studied the matter over for two weeks and suddenly I happened to think of fly-paper. I said to meself, "Fly-paper your goin' to stop these belts from slippin' or bust." So before I rode the next car I fastened some fly-paper on the wheel of the thing under the car, and in the big wheel that's on the axle. For the first five miles the belt stuck fine, but then it started to rain and the molasses on the fly-paper melted in the water and run off. Then the belt started to slip because there was no lights on the car, and Jimmy said that's where the trouble would be. But I remembered the old sayin', "If you don't try and do succeed, don't give up." So I spent another week at home nights a-thinkin' about the belts a-slippin'. "Ha, ha," says I to meself, "now I have it, sand-paper!" "Sand-paper," I says, "your it." So I lined the belt inside with sand-paper with the rough side toward the wheels. Then I tried it out. It worked all right at the start, but when they got goin' fast, my, how the sparks did fly. Some feller said it looked like a Fourth of July celebration, and another feller said it put him in mind of a thunder and lightenin' storm. The sparks flew in all directions and set fire to the car, so they had to stop the train and have the Squirrelville Fire Department put the fire out. It caused a two-hour train detention and the conductor's report read as follows: "Hinkey Dee, the electrical expert, slipping on the belt, applied sand, and threw sparks a-settin' fire to the car." But I didn't care, I just made up me mind I'd stop the belts from slippin' if it took two years to do it. Shortly after that I saw Jimmy Goat fixin' a blow-out on an automobile tire. He was patchin' the inner tube and used some kind of sticky stuff. The thought flashed through me head that that would be just the thing to stop the belts from slippin'. I asked Jimmy Goat what that stuff was and he told me it was "Hold 'Em Forever Cement." So I didn't tell Jimmy Goat about it because he might try to beat me to it, and invent it first. I bought two gallons of the "Hold 'Em Forever Cement" and covered the wheels and belt with it. When I put the cement on I allowed meself one hour before train time so's the stuff could dry. I said to meself, "If this 'Hold 'Em Forever Cement' doesn't hold 'em forever me name isn't Hinkey Dee." Finally the passengers were all aboard and the conductor pulled the whistle to start, but the old engine couldn't get the train started, no, it simply couldn't move the train an inch. At first they thought the brakes were sticking. Then they thought something else and after a half hour's detention guess what they made me do? Why, they actually made me cut the belt off so they could start the train. But I'm still not convinced that it was "Hold 'Em Forever," and some day when nobody's around I'm goin' to try it again.

The South Manchurian Railways have ordered 26 Decapod locomotives from the American Locomotive Company. These locomotives will have 23 by 28 in. cylinders, and a total weight in working order of 202,000 lb.

COMMITTEE ON ELECTRICITY REPORTS

At the convention of the American Railway Engineering Association held at Chicago during March the Committee on Electricity presented some interesting information relative to the use of electricity on the railroads. Several of the sub-committees were unable to present reports on the subjects assigned to them, but the work of the sub-committee on "The Utilization of Water Power in Connection with Electrification Projects," was particularly interesting, as the committee was able to gather some very important data on this subject.

Last year the general committee submitted to the association a list of technical definitions and the association tentatively adopted and published them in the Proceedings with the understanding that the membership would have an opportunity to consider and offer suggestions to the committee. The following list of definitions has been revised and is now submitted for adoption and printing in the Manual. These definitions, so far as possible, conform with those in use by the U. S. Bureau of Standards and printed in the National Electrical Code and those of the American Institute of Electrical Engineers. It will be noted that the definitions are arranged in alphabetical order rather than in logical sequence. This has been done with the view of conforming to common usage in the Manual. Words in parentheses after each definition indicate new definitions by the word "proposed" or the source of existing definitions.

Electrical Definitions

Bond.—A metallic means for connecting conductors to permit passage of electric current. (Proposed.)

Bonder.—An employee assigned to install or maintain bonds and their appurtenances. (Proposed.)

Bracket Support.—An arm supporting the trolley wire or catenary. (Proposed.)

Bridge Support.—A rigid overhead structure supporting the trolley wire or catenary. (Proposed.)

Cable Conductor.—Wires bound together acting as a conductor. (Proposed.)

Catenary Suspension.—Any form of trolley construction supported by a longitudinal wire or cable. (Proposed.)

Clearance Line (Equipment).—The line beyond which no part of the equipment shall project. (Proposed.)

Clearance Line (Third Rail).—The line beyond which no part of the third rail structure shall project. (A. R. E. A. Manual.)

Conductor.—A metallic path for the flow of electricity. (Proposed.)

Contact Conductor.—That part of the distribution system other than the traffic rails which is in immediate electrical contact with the circuits of the cars or locomotives. (A. I. E. E. 706.)

Contact Rail.—A rigid contact conductor. (A. I. E. E. 767.)

Contact Rail (Overhead).—A rigid contact conductor above the elevation of the maximum equipment line. (A. I. E. E. 768.)

Cross-Span Support.—Overhead wire or cable supporting the trolley wire or catenary. (Proposed.)

Direct Suspension.—Any form of overhead trolley construction in which the trolley wires are attached by insulating devices directly to the main supporting system. (A. I. E. E. 780.)

Distributing System.—That portion of the conductor system which carries current of the kind and voltage received by the cars or locomotives. (Proposed.)

Duct Line.—A structure consisting of one or more tubes and chambers for the housing of wires or cables. (Proposed.)

Jumper.—A cable used to connect the ends of two contact conductors. (A. R. E. A. Vol 18, page 145.)

Patrolmen.—Employees assigned to inspect track and third rail structures, cables and wires. (Proposed.)

Pulling Chamber.—A chamber in a duct line provided for pulling cables and wires into ducts. (Proposed.)

Splicing Chamber.—A chamber in a duct line, in which cables are spliced and inspected. (A. R. E. A., Vol. 18, page 144.)

Substation.—A structure and its contained group of apparatus or machinery which receives current from a transmission system, changes its kind or voltage and delivers it to a distribution system. (A. I. E. E. 762.)

Third Rail.—A contact conductor placed at either side of the track, the contact surface of which is located a few inches above the level of the top of the track rails. (A. I. E. E. 769.)

Third Rail Gage.—Distance measured parallel to plane of top of both running rails between gage of nearest running rail and inside gage line of third rail. (A. R. E. A. Manual.)

Traction Linemen.—Employees assigned to install or maintain wires and cables and their appurtenances for all railroad voltages. (A. R. E. A. Manual.)

Lineman (New).—Employees assigned to install or maintain wires and cables and their appurtenances. (Proposed.)

Transmission System.—That portion of the conductor system carrying current of a kind or voltage different from that received by the cars or locomotives. (Proposed.)

Transmission Line.—A system of towers or poles and cables or wires carrying current from the source of power to the substations. (Proposed.)

Trolley Wire.—A flexible contact conductor customarily supported above the cars. (A. I. E. E. 777.)

The sub-committee on water power has to some extent investigated the utilization of water power for electric railway operation and has collected some data to indicate to what extent water power is now used to generate electricity for the operation of steam railroads. In the following table are the principal steam roads which have been partially electrified, the source of power, and the approximate annual current consumption. In the case of those roads using current generated by steam, the reason why water power was not used is given so far as obtainable.

Electrified Steam Railroads—1917

The development of any water power for a certain kilowattage should require that the combination of

stream flow and reservoir capacity is capable of developing the same kilowattage throughout the year. In the Middle Atlantic and New England states, within a reasonable distance—not to exceed 200 miles of any railroad having a dense traffic and excluding Niagara Falls—the streams where an appreciable head is available are erratic as to stream flow. A small amount of power can be developed economically, but to develop an amount reasonably to be expected from a central station requires either a reservoir or an

Line	1917, miles electric track.	Trolley voltage	Kind of Service, passgr.2and frt.	Power from	Kw. Hr. 1917 at power house for trains	Reasons for not using water power
P. R. R., N. Y...	97	650 DC	P	Coal	64,290,840	None available
L. I. R. R., N. Y..	208	650 DC	P	"	97,382,970	None available
P. R. R., Phila...	95	11,000 AC	P	"	23,100,360	None available
W. J. & Seashore.	150	650 DC	P	"	32,825,600	None available
Grand Trunk	12	3,300 AC	P&F	"	3,913,300	None available
Nor. & Western...	90	11,000 AC	F	"	56,651,700	Coal cheaper
New York Central.	253	650 DC	P	"	102,585,000	None available.
N. Y., N. H. & H.	530	11,000 AC	P&F	"	90,500,000	Some water pr.
M. C., Detroit....	25	650 DC	P	"	7,431,000	None available
Hoosac Tunnel ...	21	11,000 AC	P&F	Both	7,727,000	
B. & O., Baltimore	8	650 DC	P&F	Water	6,200,230	
C., M. & St. P. R.R.	600	3,000 DC	P&F	"	124,600,000	
B. A. & P.....	90	2,400 DC	F	"	23,408,270	
Erie (Roch. Div.).	38	11,000 AC	P	"	1,894,860	
Great Northern ...	10	6,600 AC	P&F	"	4,080,000	
Southern Pacific...	138	1,200 DC	P	"	27,844,000	
Total 2,365					675,000,000	

auxiliary steam station. The result of this is usually a plant in which the capitalization is so excessive that, in spite of the low operating cost, electrical energy cannot be produced at a price to compete with that generated in an all-steam station of like capacity and economy.

A concrete example of fuel saving by the substitution of electric for steam operation where comparable statistics are available in the electrification of the Chicago, Milwaukee & St. Paul between Avery, Idaho, and Harlowton, Montana, a distance of 440 miles and comprising an electrification of 600 miles of track. During 1917, 124,000,000 kw. hr. (equivalent to approximately 3,900,000,000 ton miles) were generated by water power for the operation of trains. Based upon actual records taken prior to electrification, 220,000 tons of coal and 453,000 barrels of oil (equivalent to a total of 350,000 tons of coal) were burned under locomotives for an equivalent steam service. In 1917 there were 2365 miles of steam railroad under electric operation in the United States and it has been reported to the committee that during the year there were 675,000,000 kw. hr. generated for the operation of trains over these electrified tracks. Applying the figures obtained from steam and electric operation of the Chicago, Milwaukee & St. Paul Railroad to all of the roads electrified, would result in a saving of 1,890,000 tons of coal per annum, had it been possible to produce all of this electrical energy by water power.

A concrete example of fuel saving, where coal is used to generate electric power, is furnished by the Norfolk & Western electrification of about 90 miles of track between Bluefield and Vivian. During the year 1917 there was generated 56,652,000 kw. hr. for the operation of trains, using 87,160 tons of coal at the power house. Based upon records of coal consumption on steam locomotives on the Norfolk & Western, 147,600 tons of coal would be required for an equivalent steam service. Applying a similar saving to the 2365 miles of electrified steam railroads would show a saving of 720,000 tons of coal per annum if all electric energy had been generated by steam power plants.

The total developed water power of the United States is reported by the Secretary of Agriculture in 1916 as 6,500,000 hp. The undeveloped water power is reported in Senate Document 316, dated 1916, as 53,900,000 hp., of which 39,200,000 hp. is within the limits of the Rocky Mountains and Pacific Coast states.

Calvert Townley in a statement to a committee of the United States Chamber of Commerce on January 14, 1918, made in behalf of the Engineering Council, calls attention to the fact that the federal government still retains as proprietor more than two-thirds of the total area of the 13 western states in which the bulk of the undeveloped water power is located. If any parts of the public lands are needed for reservoirs, dams, transmission lines, etc., a permit of the Secretary of the Interior is required, which is revocable at any time, without cause. Other water powers are on navigable streams, and require an Act of Congress for their development. A revision of these laws is under consideration. Outside of the western water power states and the territory tributary to Niagara, water power generally should be developed with auxiliary steam power.

Conclusions

(1) It is important to reduce the use of coal where possible by the development of water power.

(2) Water power will show the greatest economy in the West on account of the higher cost of coal and minimum cost of water power development, but may show economy in other districts at present or future coal prices.

(3) In general, auxiliary steam plants should be built, to develop the water power beyond its minimum capacity, and to secure reliability of service.

(4) Laws should be modified to permit the development of water power on public lands and on navigable streams, under reasonable restrictions.

(5) In its studies and investigations of this subject the committee have been impressed with the failure of some of the carriers to so keep their records as to permit the proper segregation of data which is necessary to calculate the tons of coal consumed in steam locomotives separated from coal consumed for other purposes on sections or divisions where electricity has been substituted for steam.

Recommendations

The committee recommend the following for your action:

(1) The adoption and publication in the Proceedings and in the Manual of the electrical definitions, and continue the examination of the subject-matter in the Manual pertaining to Electricity.

(2) Continue collecting statistical data relative to clearances of third rail and overhead working con-

ductors, and submit revised tables at the next annual meeting.

(3) Continue the subject of the revision of joint specifications for transmission line crossings over railroad companies' right-of-way and send delegates to co-operate with committees of the American Railroad Association and of the American Electric Railway Engineering Association and the United States Bureau of Standards.

(4) Continue the subject of electrolysis and insulation and send delegates to co-operate with the American Committee of Electrolysis in the preparation of its future report.

(5) Continue the subject of maintenance organization and relation to track structures.

(6) Accept as information and publish in the Proceedings the report on water power. In this connection the committee desires to call attention to the fact that it has found but little data bearing on the cost of steam railroad operation applicable to divisions where electric operation has been established, and urge upon engineers and accounting officials the desirability of so arranging the accounts as to accurately show the cost of steam operation and that such accounts be available before attempting to compute the cost of electric operation.

(7) Accept as information and publish in the Proceedings the report on Electrical Interference, and continue the subject.

(8) Accept as information and publish in the Proceedings the committee's report on the National Electrical Safety Code, and continue co-operation with the United States Bureau of Standards in the preparation of Safety Codes.

(9) The acceptance and publication in the Proceedings of the report as a whole.

Committee: Edwin B. Katte (N. Y. C.), Chairman; A. G. Shaver (Cons. Engr.), Vice-Chairman; A. H. Armstrong (Gen. Elec.), H. M. Bassett (N. Y. C.), Z. M. Briggs, (Pa. Lines), D. J. Brumley (I. C.), H. M. Church (B. & O.), C. S. Churchill (N. & W.), R. D. Coombs (Cons. Engr.), Walt Dennis (Wab.), R. H. Ford (C. R. I. & P.), W. F. Graves, G. W. Kittredge (N. Y. C.), C. E. Lindsay (U. S. R. R. A.), H. K. Lowry (C. R. I. & P.), W. L. Morse (N. Y. C.), W. S. Murray (Cons. Engr.), Frank Rhea, J. R. Savage (L. I.), M. Schreiber, H. U. Wallace.

Discussion

(E. B. Katte (Chairman) introduced the report and it was accepted as a whole for publication in the Proceedings.)

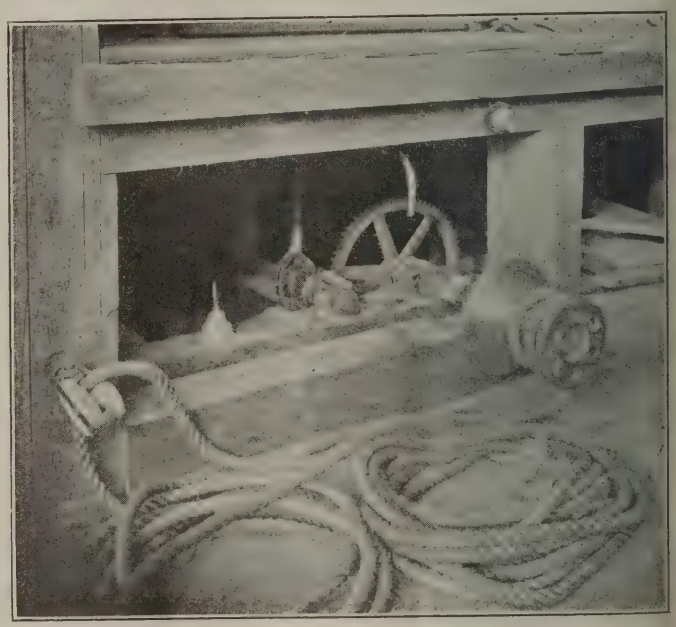
(Mr. Katte then introduced Mr. Wagner of the Bureau of Standards.)

M. W. Wagner (U. S. Bureau of Standards): I would like to have everyone here today familiar with the present status of the National Electric Safety Code. We have a proposed revision of it, which deals with overhead and underground circuits of all kinds. We have submitted it from time to time to those who are vitally interested for suggestions as to positive changes to be included in this revised copy and we are receiving suggestions which are of great value. This proposed revision has been submitted to a number of conferees who are to go over it and give us the benefit of their criticism. We are about to receive these criticisms and comments, and as soon as they are in and the various suggestions have been boiled down, it is likely there will be a conference held in Washington or New York, or some other easily accessible place, where further discussion and criticism will be given. After that, a lithographic copy of the revision will be issued, which will show wherein changes are made. We hope to submit this to a general conferee list. If there are any members of this association who would like a copy of that report, we will send it.

(The committee was dismissed with thanks.)

NOVEL METHOD FOR MOVING CARS

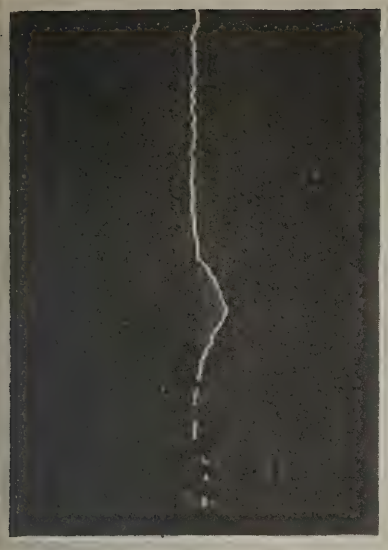
The Pasco Flour Mills Company, of Pasco, Washington, in a new mill that has installed electric drive throughout, is utilizing their drive in an ingenious manner to solve this problem of placing the car. The main shaft in the mill is driven by one Westinghouse 40 h.p., 3-phase motor. A counter shaft, driven from this main shaft, projects through an aperture in the wall of the mill to the loading platform. Attached to the end of the counter shaft is a steel drum which acts as a spool for a coil of 1¼-in. rope. The loose end of this rope is attached to



Novel Drum for Moving Car on a Siding at Pasco Flour Mills, Pasco, Washington

the coupler of the car to be moved by means of a steel hook. By throwing the counter shaft in gear the drum revolves and moves the car. The direction of the pull from the drum is made by changing the wind of the rope on the drum.

From the same drum a power scoop is also operated which unloads bulk wheat into the bulk elevator hopper, unloading 1,200 bushels per hour. Two men are all that are required to operate the scoop by using this drum, whereas it formerly took six. The drum has increased the unloading capacity from four to six cars a day. The scheme is homemade and seems to suggest to other manufacturers a labor-saving device worth considering.



Lightning and Its Effects

Some of the Characteristics of the Discharges as Revealed From a Study Made With a Fixed and a Revolving Camera

By D. J. McCARTHY

Chief Engineer, Chicago Railway Signal & Supply Company, Chicago

Taken With the Stationary Camera

Taken With the Revolving Camera

LIGHTNING has been a source of fear and wonderment to man for centuries. The ancients were terrified by its manifestations, for it is humain to stand in fear of nature's forces, the laws of which we do not understand.

It is now some 160 years since the statesman-scientist, Benjamin Franklin, proved by his famous kite experiment that lightning and electricity were of the same identity. Previous to this, it is not to be wondered at that the blinding flash of lightning, accompanied by its rumbling, clashing peal of thunder, along with the physical manifestations of destruction it wrought upon objects, would cause terror in the heart of man. Since the identity of electricity and ligtning has been proved, man's fear of it has lessened in direct proportion to the growth of his knowledge until he has come to look upon it as a beautiful and wonderful manifestation of one of nature's forces, seemingly running rampant, although it must be following nature's well defined laws, with which man is not yet familiar. During the 160 years, what knowledge has been gained of this phenomenon?

From the result of scientific research which was carried on during the years immediately following Franklin's famous experiment in the endeavor to reach an explanation of the causes of atmospheric electricity, we note the advancement of several theories. As these explanations were but theories difficult of proof, we find in the early history of the electrical art that most of man's energy and ingenuity were spent upon the development of practical apparatus for the generation of electricity upon a commercial basis. The practical electrical engineer considers the phenomenon of atmospheric electricity as a purely scientific one, and not of enough practical importance to warrant his serious consideration. Therefore the problem of its causes was left for the scientist and theorist to evolve.

When man attempted to transmit electricity over any distance from the point of generation he soon learned in the school of experience that lightning was a phenomenon which must be seriously considered if he hoped to succeed. Ever since this lesson has been learned man's ingenuity has been tested to the utmost in endeavoring to protect his apparatus from destruction by lightning. Although some very good fortifications have been devised for this protection the lightning up to the present time is still on the offensive, and just when man thinks he has things well protected, it will get in a long range shot, making a direct hit with disastrous results to some cherished piece of electrical apparatus.

Lightning Characteristics

One theory advanced in explanation of the characteristics of the lighning flash is that it is oscillatory. Some scientific authorities ascribe to it a frequency of over a million cycles per second. This theory is strengthened by the effect of lightning discharges upon long transmission lines. Voltage surges and the phenomena which take place on these lines during atmospheric electrical storms are the same in effect as that which would be induced by a current of high frequency, but some scientists have doubted that the discharge is at all oscillatory in nature when the long path of a lightning flash, sometimes exceeding two miles, and its apparently extreme short duration are taken into consideration. The theory that lightning discharges are not oscillatory is difficult of proof, as the effects produced by such discharges would indicate that it was of an oscillatory nature.

Our knowledge of electricity is limited to the effects which it produces, and those holding to the oscillatory theory would have the advantage were it not for the fact that the science of photography during the past few years has played an important part in the research work on atmospheric electric discharges. Shortly after the camera was brought into use to record the lightning flashes, it was discovered that some of the pictures showed the discharges to be very broad, appearing as if they were wide ribbons of fire. Other photographs showed a number of discharges side by side which indicated that several occurred which were exact duplicates of each other. Here was shown a phenomenon that previously was not known to exist and one that could not have been manifested to the human eye by any other means than photography, as we cannot rely on the evidence of our senses for an exact record of events cover-

ing observations which can only be made during a fraction of a second.

In explanation of such remarkable photographs, it was suggested that the lightning flashes were made up of several discharges following each other in rapid succession. The opinion held was that the condition which caused the first discharge from the clouds prevailed for some considerable time, so that the clouds were immediately recharged and again discharged through the path of heated gases caused by the first one, each succeeding one passing over the same path as the previous discharge. These continue until the conditions causing them have ceased to exist.

The Camera as an Aid in Scientific Investigation

The individual discharges are made visible in the camera because the path of heated gases is some times moved sideways by strong winds. If this is actually what happens we have a good explanation of the phenomena taking place in transmission lines during electrical storms, for if each individual discharge composing a lightning flash were a dampened discharge, that is, without oscillations, the rapidity and suddenness with which they accur would no doubt cause surges of high frequency in such lines, similar to those that would be induced by a current of high frequency.

A few engineers were skeptical as to the accuracy of

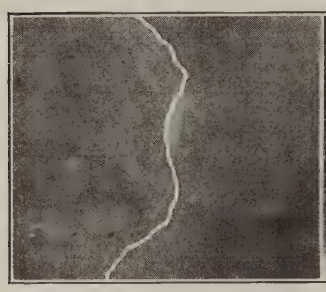


Fig. 3

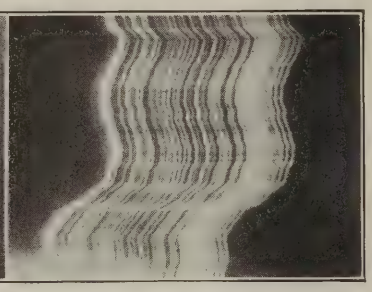


Fig. 4

such photographs. This was true among those who were not familiar with the science of photography. They maintained that the pictures were the result of some peculiarity of the photographic plate or unusual characteristic of the camera. It was suggested that the camera may have been moved during these exposures. The photographer-scientist knows that the pictures showing the lightning as broad bands might be caused by a movement of the camera during exposure, and he also realizes that it would be impossible to produce pictures of the multitudinous flashes by any such movement.

The assertion that the camera may have been moved suggested to the photographer the idea of moving his camera during these exposures. This was done by swinging it from side to side with the shutter open until a flash had been recorded. The results from this procedure were very marked. With the stationary camera the photographs showing the multitudinous flashes were very rare, whereas the moving camera showed that about 90 per cent of them were multiple, and even photographs made in this manner were accepted by some with skepticism.

The writer, wishing to satisfy his own curiosity and allay the skepticism of others, has been taking photographs of lightning for the past few years whenever the opportunity presented. The method of taking these photographs was to use two cameras, one stationary and the other moving. This procedure was employed so as to secure two pictures of one flash, one being taken with the stationary camera, which would show the flash as seen by the eye, and one by the moving camera, which would record the number of discharges. The moving camera, instead of swinging from side to side, was rotated in such a manner that the speed of rotation could be accurately controlled. When the speed of rotation of a camera and the focal length of its lens is known it requires only a simple calculation to determine the duration of a lightning flash. If careful note is made of the time elapsing between when the flash takes place and when the first sound of thunder is heard, the length of the discharge path can be estimated with a fair degree of accuracy. In determining the distance from where the flash takes place and the location of the camera by the speed of sound it is very important that careful note be taken of

Fig. 5, Bottom View; Fig. 6, Top View

the velocity and direction of the wind at the time of making observations.

The Length of Flash and Time of Discharge

The illustrations at the head of this article are copies of photographs of a lightning flash taken with a stationary camera and with the moving camera. This flash was composed of four discharges following each other at comparatively long intervals. The first discharge is the one on the extreme right and was followed by another discharge at an interval of 0.12 of a second; the third discharge occurred 0.09 of a second later and the time between the third and last discharge was 0.06 of a second. The duration of this flash would be approximately 0.27 of a second. The gradual decreasing of intervals of time between the first and last discharge may be explained by

the fact that each succeeding discharge raised the temperature which causes a higher degree of rarefication of the gases in its path, thereby reducing its resistance so that the voltage of the charge in the clouds is considerably less for each succeeding discharge. After each succeeding discharge, therefore, the time of generation for the last charge would be less than for the first. It will be noted that the first and last discharges are the brightest. This is noticeable in most of the photographs of this kind and as yet there is no satisfactory explanation for it. The estimated length of this flash, as shown in the photograph, is approximately 1.5 miles long. The time intervals given above do not denote the actual time for individual discharges, but represents the time between them. The actual time of individual discharges is very short.

Flashes of this type comprising so few discharges are apparently of rare occurrence. The writer has only been able to secure three during the past seven years, although other observers may have been more fortunate. Most flashes show a much larger number of discharges, as is illustrated by Figures 3 and 4. Figure 3 is a record of the same flash taken by the revolving camera. The sequence of the discharge shown in this photograph occurred from left to right and the number of discharges are approximately 36. The time intervals between discharges are very irregular, although the average time between them at the beginning of the discharge is longer than that of the finish. There is also a very marked difference in the magnitude of the several discharges and what seems very peculiar is that the first two discharges are very faint in comparison with the third, which appears to be the main one. This is also a rare occurrence, as in most flashes the first discharge stands out clear and strong. The duration of this flash was 0.55 of a second and the estimated length of what is shown upon the plate is 0.76 of a mile.

In all, the most striking record that it has been the good fortune of the writer to secure is shown in Figure 5, which was made by the stationary camera, while Figure 6 was the one made by the revolving camera. Both pictures show the same flash. These were secured during one of the first electrical storms of the season which occurred during the early part of April. The weather was quite cold and this particular storm broke shortly after midnight and continued until the early hours of the morning. The flashes were extremely clear and vivid, following each other at approximately three minute intervals. The one shown here occurred at four o'clock in the morning, the thermometer registered a temperature of 42 deg. No rain was falling at the time nor had there been for two hours previous. The wind was blowing approximately 35 miles per hour. At least 44 discharges can be counted in this flash. The estimated time of duration is 0.71 of a second. Assuming that the flash occurred over a plane equal in distance from the camera, its estimated length is 2.56 miles. It is very probable that such a flash is irregular along the axis of the camera as well as right angles to it, which would make the actual length of the discharge much longer than that stated above. The thunder from this flash persisted for seven seconds and was very irregular in volume.

The Knowledge Gained from Photographs

From such photographs some knowledge of the rolling of the thunder may be obtained. These individual discharges no doubt must have some bearing upon the phenomenon. These records show that the duration of the lightning flash is considerably longer than what it is popularly supposed to be, but that the individual discharges going to make it up are extremely short.

We can also gain some knowledge of the enormous amount of energy expended in these lightning flashes. Where voltages of such value are generated as to cause a flow of current over an air gap of two or three miles, wires having a capacity sufficient to require a current of 200 amperes to fuse them have been vaporized for a distance of several feet by such discharges. This amount of current with the voltage necessary to send it over such an air gap has an energy value in k.w.'s that is hard to realize. This illustrates the problem the electrical engineer has to solve before his apparatus is immune from the dangers of the lightning discharge; also the absurdity and presumption on his part to attribute the name "Lightning Arrester" to his protective apparatus. When the lightning once starts on its journey from the clouds to the earth, it will reach the earth regardless of man's greatest efforts to arrest it. He may to some extent divert it from the path it would naturally follow, but he can never stop or arrest it.

DEMONSTRATION OF EQUIPMENT BEFORE NEW YORK CAR LIGHTING CLUB

The members of the New York Car Lighting Club at a special meeting held at the battery house of the Delaware, Lackawanna & Western railroad at Hoboken were given the opportunity to witness an interesting demonstration of the Gould car lighting equipment. The meeting had been scheduled for the fourth of March but owing to a delay in the arrival of the apparatus it became necessary to postpone the demonstration until March 12. The attendance was the best of any meeting held by the club this year. The interest taken by car lighting men in this vicinity was clearly shown by the fact that not a few of those present came long distances to witness the demonstration and the various tests made were keenly followed by all.

The equipment furnished by the Gould Coupler Company consisted of a three kilowatt generator, a motor, a standard generator regulator panel, a standard lamp regulator and a controller for operating the motor which was used to drive the three kilowatt generator. The lamps and the batteries were supplied by the D. L. & W. railroad and the entire outfit was installed by the electricians of this road under the supervision of George Wall, car lighting foreman at Hoboken.

A meter which indicated the miles per hour was connected to the motor shaft so that the various speed conditions could be studied. Battery and lamp loads were made to conform with those of the car on the road. The highest speed that could be obtained with the outfit corresponded to a train speed of 55 miles an hour. Numerous tests were made using various lamp loads from one lamp up to the total number required for a car. In all cases the prompt action of the regulator in maintaining the voltage across the lamps at practically a constant value, was clearly manifested.

In one instance the voltage coil was opened thus permitting the voltage to go where it would, but the difference in the brilliancy of the lamps was scarcely noticeable. The same tests were applied to the new type M-3 lamp regulator panel which had been set up adjacent to the other outfit and it was found that a voltage of 30 was maintained on the lamps with the generator voltage at 33. In cutting the arm loose from the voltage coil the voltage on the lamp regulator changed from 32 volts to 31 volts in three seconds and remained at this value. This test showed the M-3 regulator to be the quicker acting.

On the voltage coil of the latest type of the Gould Coupler Company's regulator panel a differential winding has been placed consisting of five turns of a heavy flat conductor which carries battery current. This winding is so placed that it acts in direct opposition to the finer winding of the voltage coil and assists in maintaining 36½ volts across the line.

One interesting test was made in connection with the contacts of the cut-in switch. The carbons were removed from this switch and the most adverse conditions applied to its operation, at which time it was expected that more or less arcing would occur when the switch dropped out. During this test the room lights were cut off in order to make more marked any arcing that might take place. Contrary to what had been expected practically no arcing was seen. This test showed that the use of carbon contracts on the cut-in switch is almost unnecessary.

The following are a few of the questions that were asked during the evening:—In which side of the circuit should the main fuse be placed? *Ans.* It is immaterial which side this fuse is inserted except that at one time we had two positive circuits to be protected and this was accomplished by inserting the fuse in the negative side of the line. How high does the field current run when the generator first picks up? *Ans.* About five or six amperes. This value is cut down somewhat as the speed rises. Does harm result from charging batteries at higher than normal charging rates? *Ans.* Not if temperatures are kept below 95 degrees Fahrenheit. A charging current considerably in excess of normal may be put in, if battery temperatures do not exceed this value. Are best results obtained by a high charging rate? *Ans.* Yes if temperature is watched. Are the lamp regulator carbon piles of the M-3 type in series or parallel? *Ans.* They may be connected either way. What kind of liquid is used in the dash pots on the regulators? *Ans.* We use "Dasho" which will stand high temperatures and does not affect the operation of the regulator. These and many other questions were asked by the members of the club and answered by M. R. Shed and D. R. Burger of the Gould Coupler Company.

The final question which we have given in connection with the liquid used in the dash pots, provoked some discussion concerning the particular properties of the liquid sold under the trade name of "Dasho." Some of the men who have been using this particular oil claimed that after a number of months in actual service that the liquid turned to a greenish blue color and had a tendency to scum over. In the opinion of Mr. Burger this condition was brought about by some impurity having been introduced into the dash pot. Mr. Kershaw, president of the club, stated that he had experienced the same conditions with "Dasho" but that he had rectified it by removing the scum and adding a small quantity of water.

At the conclusion of the meeting a vote of thanks was tendered to the representatives of the Gould Coupler Company for their kindness in making the demonstration possible and also to Mr. Wall and his associates for the time and labor spent in setting up the apparatus and preparing the room for the meeting. Mr. Kershaw called attention to the next regular meeting of the club to be held the first Tuesday in April, and suggested that further discussion concerning the Gould equipment be taken up at that time.

* * * *

The discussion was continued as follows at the meeting on April 1, held in the Grand Central Terminal, New York: At the last meeting some one suggested that the carbon piles in a lamp regulator might be used parallel. Has any one actually been using the piles in parallel? *Ans.* Yes. Here in the Pennsylvania yards we have been using all of them in parallel to take care of the heavy loads. This at one time would cause hunting, but this was overcome by using three-sixteenth-inch carbon instead of one-quarter inch. Are the current coils identical on the three and the four kilowatt regulator panels? *Ans.* The coil on the three kilowatt panel is wound for 75 amperes and the coil on the four kilowatt panel is wound for 100 amperes.

After a discussion of the details of manufacturing of the Gould equipment, a very interesting half-hour was spent in which the members of the club told of troubles experienced on the road, and explained the methods used for remedying them. Mr. Kershaw then produced a number of model cable splices and explained in detail just how a splice should be made and just how it should not be made.

Just before the motion to adjourn was made it was agreed that the club woud have an outing on some Sunday early in June. At the next regular meeting in May papers will be presented on the relative merits of body hung and truck mounted machines, and solid and perforated axle pulleys.

The Vitality of the Americanization Question was put strongly to the nation during the past year in a form that was not altogether agreeable. For the draft revealed the astonishing percentage of those in this country who were unable to speak our language or to read or write any language. Yet, I take it, there is no one thing so supremely essential in a government such as ours, where decisions of such importance must be made by public opinion, as that every man and woman and child shall know one tongue—that each may speak to every other and that all shall be informed.

There can be neither national unity in ideals or in purpose unless there is some common method of communication through which may be conveyed the thought of the nation. All Americans must be taught to read and write and think in one language. This is a primary condition to that growth which all nations expect of us and which we demand of ourselves.—*Franklin K. Lane.*

Spot Welding Applied to Railroad Tinware

Illinois Central Finds Process Applicable on Wide Range of Work; Cost Materially Reduced

A LARGE proportion of the sheet metal work used on railroads is subjected to rough usage and for that reason it must be strong if it is to give satisfactory service. In order to secure the required strength, the joints in many cases must be riveted. Riveting is slow and therefore an expensive operation, especially when the rivets must be soldered to prevent leakage. The process of spot welding has been applied to the manufacturing of sheet metal ware during the past few years with great success. As the simplicity of the process and the great strength of the joints seemed to make it well adapted for railroad work the Illinois Central about a

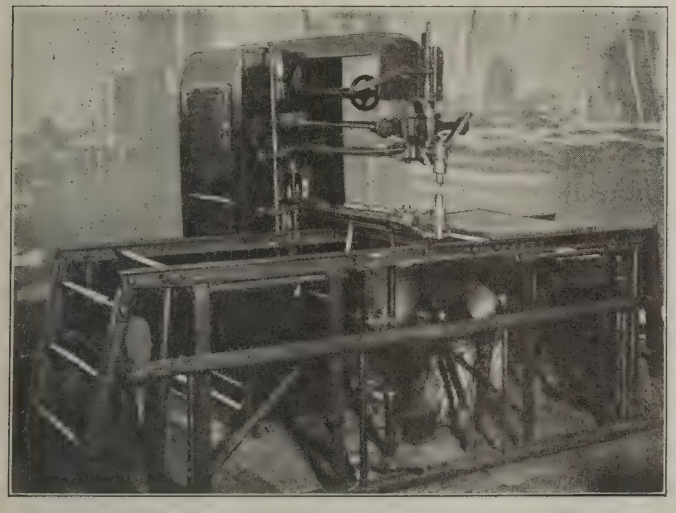


Fig. 1—Automatic Spot Welder of 10 kw. Capacity Used at Burnside Shops

year ago investigated the possible savings that could be effected and purchased a 10 kw. automatic welding machine, manufactured by the Automatic Electric Welding Machine Company, New York.

A general view of this machine is shown in Fig. 1. It consists of a case containing the electrical mechanism with two arms extending from the front to which the electrodes are attached. The lower arm can be moved vertically by a screw engaging a crosshead at the front of the frame. The upper arm is stationary, but the electrode is mounted on the end of a bell crank operated through a horizontal rod from a cam in the body of the machine. This machine has a three speed transmission driven by a ½-hp. 220-volt A. C. motor. A hand wheel at the left of the upper electrode varies the speed to give one revolution in one, two or four seconds. On the cam shaft is a magnectic clutch operated by a pedal switch on a flexible cable. If the operator presses his foot on the switch once, the machine makes one weld, but if he holds his foot on the switch one weld will follow another at regular intervals, depending on the speed for which the machine is set.

The cam action is transmitted to the bell crank through a lever and then through a horizontal pressure rod. The lever has an adjustable fulcrum providing a lift of ¼ in. to 1½ in. for the upper electrode. The pressure of the electrode on the work is changed by a hand wheel which varies the stress on the spring in the pressure rod to the bell crank. The electrodes are cooled by a continuous flow of water. The points have a Morse taper fit and are adjustable for various types of work.

The time during which the current flows is regulated by a hand wheel on the right side directly opposite the speed control. The time can be varied by small increments from zero to two seconds which makes it possible to weld from the thinnest stock up to ⅜ in. on this machine. The capacity is dependent on three factors, the amperage of the transformer, the current between the electrodes and the length of time the welding current flows, all of which are automatically controlled in the machine, after the original adjustment has been made. The machine when once set for the gage of stock involved is automatic in its action. The amperage, pressure and time are adjusted by a foreman or electrician thoroughly familiar with the work of electric spot welding, after which any operator capable of feeding the work can se-

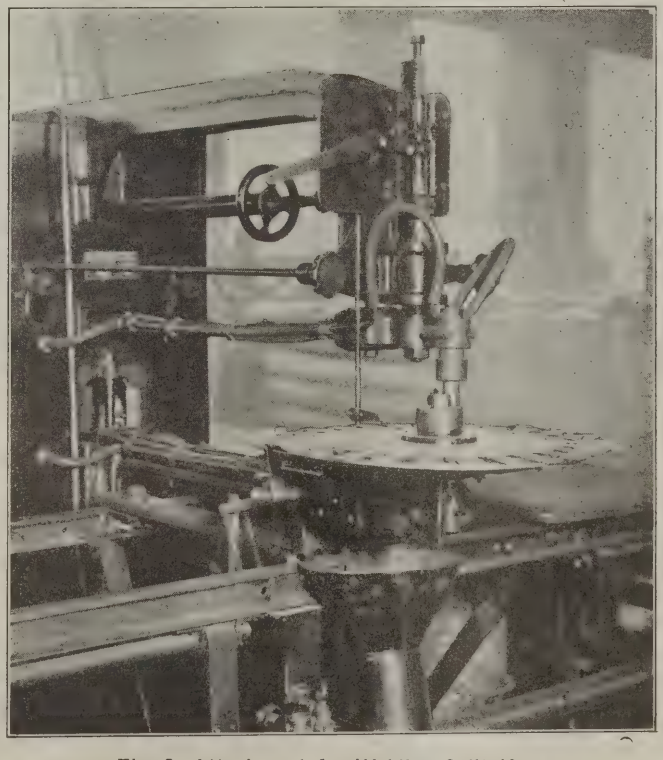


Fig. 2—Attachment for Welding Split Keys

cure perfect welds. The automatic features of the machine are important in reducing the cost of labor and in eliminating the waste due to burning or imperfect welds resulting from poor judgment on the part of the operator.

The machine installed at Burnside has proved well adapted for work on railroad tinware. It welds bright tin and black sheet iron very readily. The parts must be flat so that a good contact will be made between the contact

points and the surfaces must be free from rust. Galvanized sheets are more difficult to weld satisfactorily, but by using a slow speed and a comparatively low current with small contact points the zinc coatings can be pierced and a good junction secured. In making ventilator screens it has been found quite feasible to weld brass screens to the galvanized frame.

Table I—Savings Effected by Welding Kettle Ears

Fastening Kettle Ears by Riveting	
Punching	$0.68
Riveting	1.53
Soldering over rivets	.68
Total labor	$2.89
Rivets	.50
Solder	.30
Total labor and material	$3.79
Number of ears riveted	576
Fastening Kettle Ears by Welding	
Labor	$1.20
Number of ears welded	576

The savings effected by welding can best be illustrated by citing a few examples of typical jobs. In fastening kettle ears on buckets, the former method was to rivet them on, covering the heads with solder. Spot welding is much quicker and the cost is only 32 per cent of the cost of the riveting. A detailed statement of the cost of doing this work is given in Table I.

Another typical operation to which spot welding has been applied is making the tops for water glass lamps. These were formerly soldered at a cost of $3.40 per thousand for labor and $.40 for material. The same quantity can be welded at a cost of $.85 for labor. On this job there is no additional saving in the material from which the parts are made. When solder was used it was necessary to make the tops of tin, but sheet iron can now be used. The cost of other typical parts are tabulated in Table II.

Table II—Welding Compared with Other Tin Shop Methods

Name of part	Cost by former methods: Labor	Material	Total	Number made	Cost of welding	Number welded
Lamp chimney baskets	....	....	$10.56	100	$3.52	100
Sheet iron lamp shades	....	....	1.57	500	.85	500
Switch lamp lens bands	$20.00	$1.50	21.50	3,000	12.21	3,000
Stove pipe elbows	....	....	14.40	250	7.20	250
Ventilator screens	6.43	1.31	7.74	450	2.38	450
Split keys	52.00	10.00	62.00	20,000	30.32	20,000

The manufacture of flat split keys is one of the principal jobs handled on the spot welder. To expedite the work a special attachment shown in Fig. 2 has been devised. The framework holds a stationary disc, the edge of which is set between the welding points. Above this disc is a movable disc with recesses around the edge, of the same size and shape as the end of the cotter. Above each of the recesses is a spring which holds the parts when they are placed in the slots. At each revolution of the cam shaft the disc is advanced the distance between the slots of a ratchet operated by an electrically controlled valve, thus bringing the two pieces making up the key into position between the electrodes. A contact is then made and the parts are welded after which the ratchet advances them one notch further. The welded cotter then passes over an opening in the stationary disc where a finger on a rod attached to a lever on the upper arm of the machine strikes it, causing it to drop into the receptacle beneath. The parts can be welded as fast as the operator can feed them. As many as 5,000 cotters have been made in seven hours.

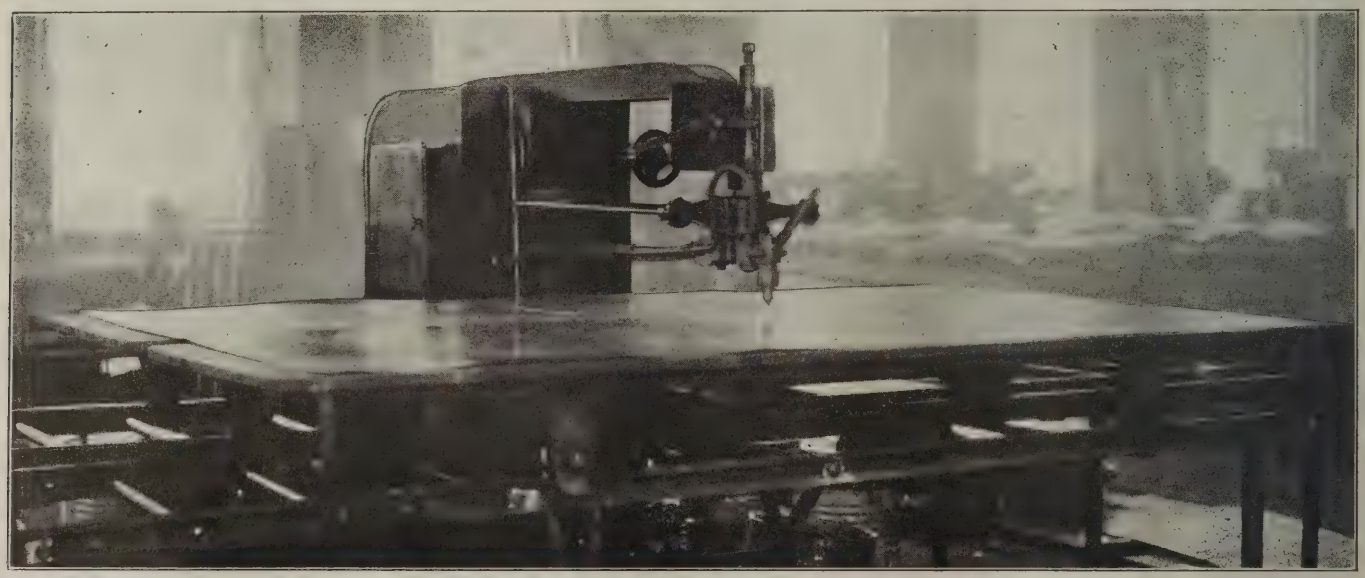
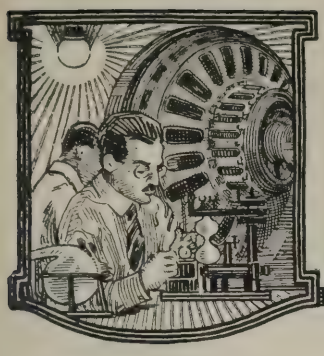


Fig. 3—Machine Arranged for Spot Welding Locomotive Jackets

Another important job for which special attachments have been made is the welding of locomotive jackets. The large sheets are placed on rolling tables as shown in Fig. 3 and are simply lapped and welded together along the edge at intervals of about ¾ in. to 1 in. The description of some of the typical parts made by spot welding as given above will serve to show the adaptability of this machine. Further developments are to be expected and devices of this type will probably become important adjuncts to railroad tinshops.

Points for the Yardmaster.—If you are not an operator at least learn the office call; this will enable you to know when to tell your operator to get busy. * * * See that your clerks keep the office in a thoroughly clean and neat condition; desks and drawers should be entirely free from books and papers that are of no current interest. File closed records and papers methodically in a convenient place, but out of the way, and do not allow useless junk to accumulate.—*H. D. McKee.*

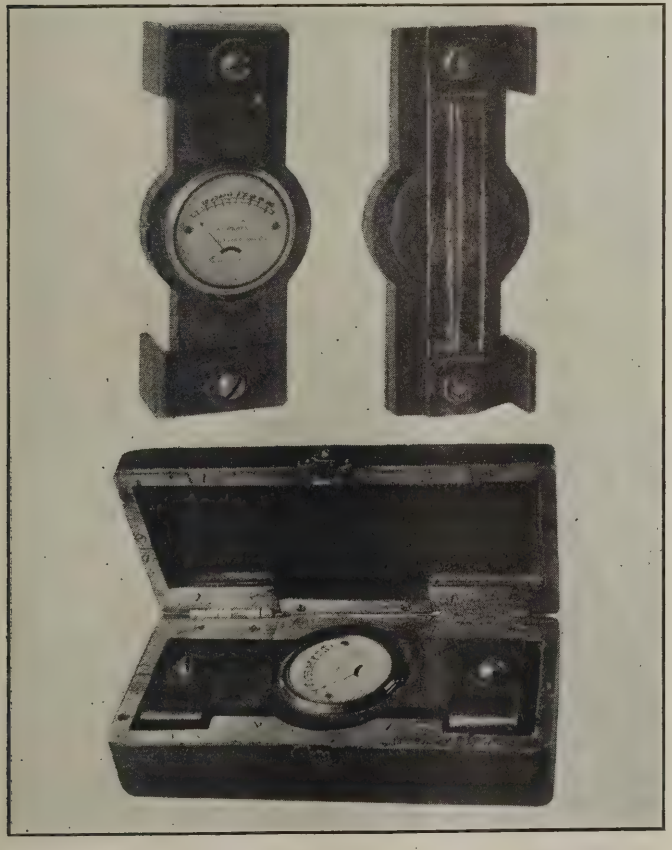


PRACTICAL STUNTS

Convenient Pocket Ammeter for Car Lighting Electricians

By E. C. Meilloret.

It is well known that all axle lighting equipment should be given frequent and systematic road inspection for in so doing any slight alteration in adjustment may be attended to before trouble develops, and the equipment is thus kept at its highest efficiency. Two of the more important things to know are the rate of charge entering the battery and the output of the generator. In order to determine this it is customary to insert an ammeter in



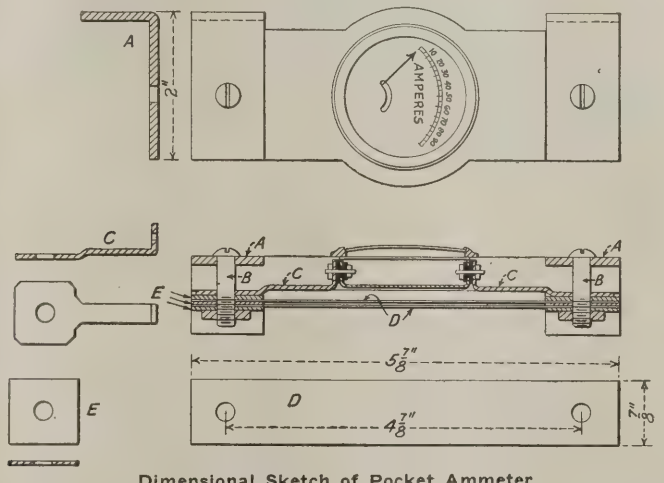
Two Views of Pocket Ammeter and Case for Carrying It

the place of the main fuse, since this is usually the most convenient place to connect it. Ammeters used for this purpose generally consist of a shunt to which is attached a pair of calibrated leads connected to a delicate instrument which makes quite a bulky combination. When one considers that the inspector must carry a few necessary tools, fuses and supplies, as well as a voltmeter, any scheme that will reduce the bulk of the equipment is particularly desirable.

For this reason I have designed a pocket ammeter which has no wires or other external appurtenances and which, when put in the place of the fuse, takes no more room than the fuse itself. It consists of a pocket battery ammeter mounted in a piece of white horn fiber ½-inch thick and 1¾-inch high, enlarged at the center to admit the instrument as shown in the illustrations.

There are at present on the market several good pocket meters. One must be selected that is rugged yet sensitive, with delicate, but strong, pivots. It is understood of course that the fiber will have to be grooved and fitted to suit the particular meter procured.

The next step is to make two pieces of copper strip, *A*, to serve as main terminals to be inserted in the place of the cartridge fuse, two brass bolts, *B*, two terminals, *C*,



Dimensional Sketch of Pocket Ammeter

and six pieces, *E*. The pieces *A* should be ⅛-inch thick and the pieces *C* and *E*, 1-16 inch thick.

Then procure two pieces of sheet manganin metal, 5⅞-inch long, ⅞-inch wide and 0.012 in. thick, or No. 28 B. & S. gage, according to *D* in the sketch. These are to form the shunt, using one of the pieces *E* between the strips at each end and the remaining four pieces on each side of both ends as clearly shown. The pieces *E* are then soldered to the strip *D*, making a substantial shunt.

Remove the present terminals of your meter and substitute the terminals *C*, taking care to thoroughly insulate these from the metal case. With the majority of instruments of this class one side of the circuit is permanently grounded to the case of the meter; it is then necessary to

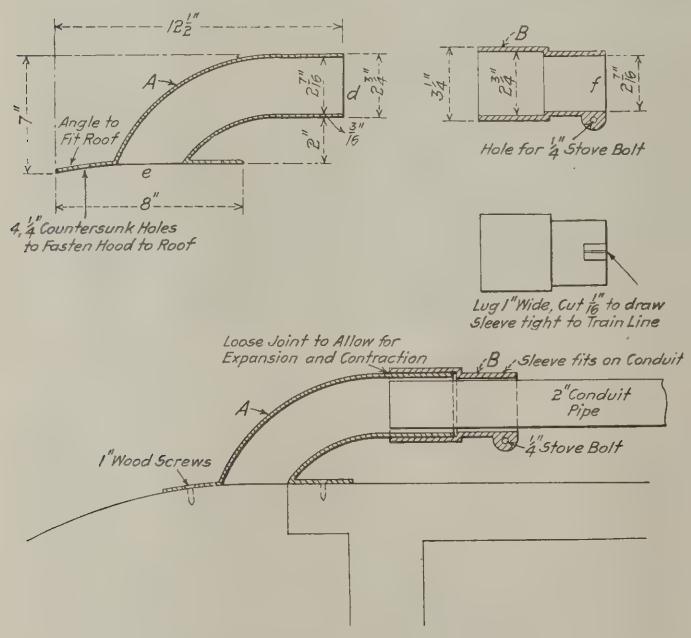
insulate only one side of the meter. The best way to insulate the terminals from the case is to drill holes in the case considerably larger than the small bolt, using a black fiber washer inside and outside. Care must be exercised to have all connections tight, well soldered and clean. The instrument may now be assembled as shown. It will be necessary to groove the back of the fiber frame to accommodate the terminals *C* and the small bolts attaching the terminals to the case.

The manganin shunt as described will accommodate 65 amperes, and assuming that the instrument was designed for a range of 35 amperes, the shunt taking 65 amperes gives a meter with a range of 100 amperes, which is ample for all axle lighting equipment. The meter must be calibrated, a new scale being drawn and pasted over the old one. The meter shown in the photographs was designed to fit on the Safety type, but by slightly modifying the size and shape of the main terminals, *A*, it can be attached to any equipment.

Solid Brass Train-Line Hood

By Carl E. Schwanz.

Many car lighting men have found that it is nearly impossible to keep the old style train-line hood in repair on account of the seams breaking by expansion and contraction of the 2-in. conduit which is exposed to the weather at the top of the car. On the Great Northern we have overcome this difficulty by making a soft brass



Details of Expansion Joint in Train Line

cast hood as shown in the illustration. The opening *d* of the hood *A* is made large enough to slip over the 2-inch train-line conduit and the angle *e* is made to fit the standard car roof *C*. In assembling, the sleeve *B* is fitted over the end of the conduit and the space between the conduit and the sleeve is filled with soft putty. The sleeve *B* is then made to slip over the opening *d* of the hood *A* and after proper adjustments have been made the sleeve is clamped tightly to the 2-inch conduit line by means of a ¼-inch stove bolt. Finally the hood *A* is fastened to the roof of the car with four No. 12, 1¼-inch wood screws which are soldered in place. The arrangement makes a watertight connection and also allows for the expansion and contraction of the conduit line.

Rotor Bars Repaired by Welding

By R. T. Trafton

Sometime ago I ran into a job which at first appeared to be a tough proposition to handle and would have been had it not been for the oxy-acetylene blow torch. The particular job to which I have reference was a Westinghouse 50-hp. squirrel cage induction motor. Upon examination it was found that the armature was pretty badly damaged, the bars having been burned loose from the short circuiting ring. At first we thought it would have to go to the factory, but it was learned that they could not repair or furnish a new armature inside of 90 days. As this rotor operated a wood planer at one of our principal car shops, to keep it out of operation would have cost the company $200 a day, therefore we had to get busy.

After renewing about twenty bars, which were too badly burned to weld, I secured an oxy-acetylene burner and welded all of the bars to the short circuiting ring and then gave them a coat of P & B paint. The rotor was then as good as when new, if not better.

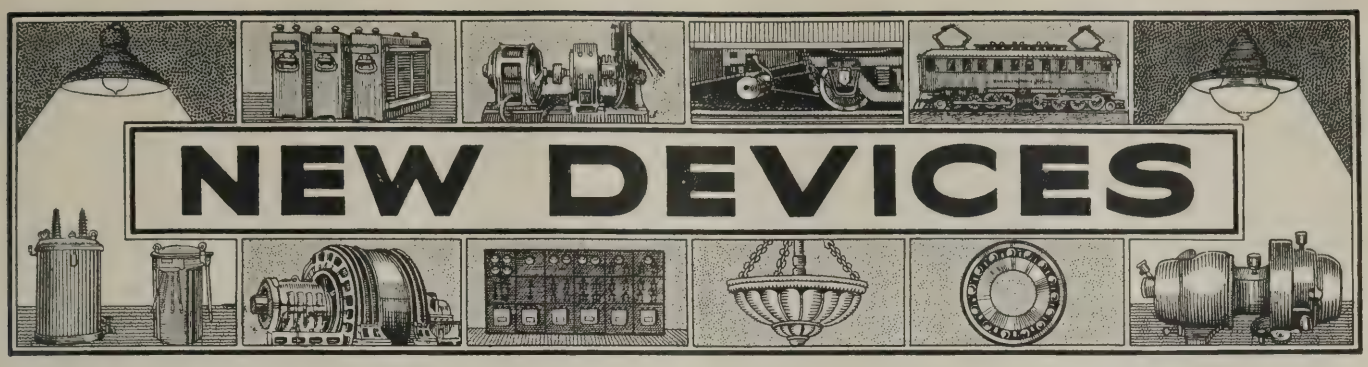
This was four months ago and the rotor has been in continuous service ever since, working nine hours a day, six days a week, under a slight overload without undue heating. Since then we have repaired several other rotors which came in from different points on the road and which were in the same fix. All are holding up perfectly.

To Keep Machinery From Rusting

It frequently happens that tools or machinery which have been in disuse for some time will develop a tendency to rust, particularly if they are kept in places that are damp. It is quite possible to prevent this rust from forming if the iron parts are carefully treated with a solution prepared in the following manner: In one pound of melted lard dissolve an ounce of camphor. A scum will form on the top of this mixture which should be removed and thrown away. Enough fine black lead should be added to the remaining liquid to give it an iron color. The machinery or tools to which this mixture is to be applied should be thoroughly cleaned. The mixture is then smeared over the iron and allowed to remain for 24 hours, after which it is removed and the metal wiped clean with a soft linen rag.

A Case Hardening Mixture

A case hardening mixture may be made of the following ingredients in the proportions stated; three parts prussiate of potash; one part sal ammoniac or one part prussiate of potash with two parts of sal ammoniac and two parts of bone dust.



An Automatic Extension Reel

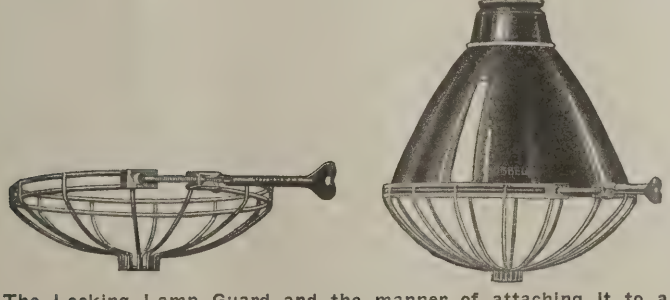
A device known as an automatic extension reel has recently been placed on the market. The reel is a simple contrivance designed primarily to take up the slack in an extension lamp cord, but may also be used in connection with portable electric drills, grinders, fans, etc.

Reel Ready for Use

The illustration gives a fair representation of the reel when in position for use. The actual size of the reel is 9 in. in diameter by 2 in. in width and is equipped with 25 ft. of reinforced cord. The head is arranged with a swivel joint enabling the lamp to be carried in any direction from the reel. An automatic lock is also provided so that the cord may be stopped and held at any point. The device has been examined, tested and listed as standard by the underwriters laboratories. The reels are being distributed by W. S. Broadhurst, 37 Cortlandt Street, New York.

Locking Lamp Guards

A new line of locking lamp guards for use with reflectors is about to be placed on the market by Harvey Hubbell, Inc., Bridgeport, Conn. As shown in the accompanying illustrations they are radically different in design from their other types, but possess the same rugged strength due to the sturdy wires and electrically welded joints. The locking device draws the guard tight around the reflector, making them practically one unit, absolutely insuring the protection of the lamp against both breakage and theft. These guards can be readily adapted to slight variations in reflector sizes.



The Locking Lamp Guard and the manner of attaching it to a Reflector.

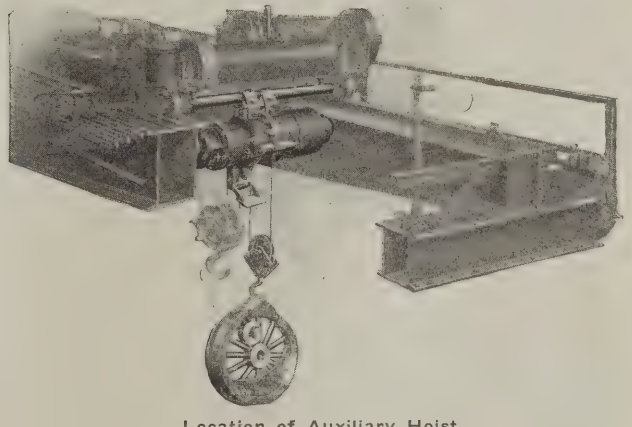
Auxiliary Hoist for Traveling Cranes

A simple and practical auxiliary hoist to be attached to any standard overhead electric traveling crane, as shown by the illustration, has recently been developed by N. B. Payne & Co., New York City.

The crane lends itself to quick and easy attachment and it is claimed by the makers that the hoist can be attached "the day it arrives."

The hoist does not take up any more room overhead, does not require an extra trolley, does not shorten the travel of the trolley on the bridge, nor does it interfere with the accessibility of the main hoist.

Ordinarily from 1 to 5 tons standard auxiliary hoists are supplied by the makers to meet the usual requirements. Larger sizes, however, are obtainable.



Location of Auxiliary Hoist

By the application of this auxiliary attachment any standard single hoist electric traveling crane may be equipped with two lines for drop bucket service. The control may be arranged from cage, floor or pulpit to suit the crane to which it is applied. It is stated that this auxiliary can be attached by the purchaser, but to assist the manufacturers such information as this should be given; kind of service; make and types of crane; span; lift; alternating or direct-current motors; voltage; phases; cycles; cage, floor or pulpit control; speed in feet per minute of main hoist at full-load and no-load; approximate weight of average crane load; number of lifts per day; maximum capacity of auxiliary hoist desired; speed in feet per minute desired at full load.

It would seem that this device would prove of value to present owners of old, slow cranes.

General News Section

W. G. McAdoo, of New York City, former director general of railroads, has been appointed special counsel to the Railroad Administration on matters arising in the state of New York, to serve without pay.

The Total Number of Passengers carried by the five companies controlled by the London Electric Railway Company—including the Metropolitan District, and the General Omnibus Company—last year, is estimated at 901,000,000. This is exclusive of passengers booked through from other railways.

The Southern Pacific reports that it has carried 46,346,228 revenue passengers during the past year without the loss of a single life in a train accident, and in the last ten years has transported 380,837,002 revenue passengers 14,480,042,394 revenue passenger miles with safety average such that a passenger may travel the equivalent of 579,000 times around the world without loss of life in a train accident.

Clocks were changed on March 30 by the railways of Canada, to correspond with changes made by their connections in the United States, notwithstanding the decision of the Canadian Government to order no daylight saving this year. Without this change of clocks the Canadian roads would have been obliged to change schedules of trains crossing the border, and of those making important connections at the border. Reports from Ottawa say that the Government has called upon the railroads to explain.

The French Minister for Public Works has approved a program adopted by the Superior Council for public works in connection with the improvements to be introduced in the communications by rail between Switzerland and ocean ports. This program includes especially the establishment of a new line between Limoges and St. Germain des Fosses, the improvement of the present express service from Bordeaux to Lyons by the strengthening of the line between St. Germain des Fosses and Lyons, and by the electrification and double tracking of the lines on the Paris-Orleans Railway, and, finally, the electrification of the difficult sections on the Tulle-Clermont-Ferrand line.

The Railroad Y. M. C. A. is planning an intensive all the year round campaign among its 300 local railway associations to bring its facilities more directly to railway men and to make the association a more important factor in the community life of railroad towns in which it is working. A "membership drive" will be inaugurated on May 18 and will extend for one week. It has been found that the war has reduced the membership in the Railroad Y. M. C. A. in America from 130,000 to 110,000, and the goal of the May drive will be to bring it up to 150,000. It is proposed that all memberships shall be made to expire on April 30 of each year. This campaign has been developed at recent conferences of association leaders in New York, Philadelphia, Atlanta, St. Louis, Chicago and other places.

Higher Telegraph Rates.—An increase of 20 per cent of all domestic telegraph rates became effective April 1 under an order issued by Postmaster-General Burleson. The increase was ordered, Mr. Burleson explained, to meet the increased cost of operation occasioned by wage increases now in effect and made during the last year.

The United States Court for New Jersey after lengthy patent litigation has rendered a favorable decision to the Gould Coupler Company against the Safety Car Heating & Lighting Company concerning the priority of certain patents on car lighting equipment. The latter company has appealed the case.

English Channel Tunnel Project Revived

The driving of the tunnel under the English Channel to France is being considered by the Government as among its projects for after the war, according to announcement by Bonar Law, who, speaking in the House of Commons, said he was discussing the matter with Premier Lloyd George as a means of finding employment for discharged soldiers.

The Daily Mail claims to have definite information that the British and French governments have agreed to the construction of a tunnel under the Channel, and that the details are now being discussed by a special commission in Paris, which also is considering the building of tunnels under the Bosporus and the Strait of Gibraltar.

The engineering plans for the Channel tunnel, according to the Daily Mail are so far advanced that work could be begun immediately.

"It is proposed," says the Daily Mail, "to start the tunnel some distance inside both countries, instead of near the coast, as was originally intended, so as to avoid the risks of a fall of the cliffs, such as already has occurred on the British side near the point where the work would have been begun.

"In addition to tracks, the tunnel will carry telephone and telegraph wires, superseding the present sea-bed cables, and also pneumatic tubes for carrying letters and parcels. The French and British railroads concerned are willing to finance the scheme, but the two governments wish to exercise control and some sort of joint state finance for the work may be adopted."

Speaking of the tunnel, the Railway Gazette (London), a few weeks ago, said: "Estimated to cost $80,000,000, a mere trifle in these days of gigantic expenditure, there is no possible doubt that the capital would speedily be forthcoming on the project receiving government approval. It is to be hoped that constructional operations will soon commence, for this essentially important traffic link between England and the continent

has been too long delayed. The cross-channel train ferry service now running with success constitutes some little endeavor to improve the means of communication, but, even under the best conditions, a train ferry is a very poor substitute for a physical connection."

A Plant to Manufacture Helium

One of the greatest accomplishments that has come out of the war is the discovery of a commercial method of the manufacture of helium. Only a very short time ago helium was known as a rare gas and the total amount stored in the tanks did not exceed more than a few hundred cubic feet. At that time the process of its extraction was so slow that a single cubic foot was valued at $1,700. At the time the armistice was signed, however, methods had been perfected whereby this cost has been reduced to ten cents a cubic foot.

In North Fort Worth, Texas, the only helium plant in the world is being erected by the United States Navy Department at a cost of $900,000. The plant is practically completed and it is expected that the production of helium from this plant will entirely remove the last danger from ballooning.

Helium has 92 per cent of the lifting power of hydrogen and is not inflammable. Heretofore, in warfare, gas filled balloons were at the mercy of airplanes which could easily set fire to the hydrogen. It is estimated by experts that the production of helium in large quantities will result in the operation of large passenger and freight airships for travel everywhere.

The natural gas of certain wells at Petrolia in Clay County is the best ever found for the extraction of the helium. The products of these wells will be piped to Fort Worth, prepared for the balloons and distributed.

The government is now building the pipe line at a cost of $4,000,000.

Organization to Promote the Use of Electric Furnace Products

Important steps were taken to promote the use of various electric furnace products, at a meeting called by Acheson Smith, vice-president and general manager of the Acheson Graphite Company, held at Niagara Falls, on Friday and Saturday, March 21 and 22.

A special emphasis was laid on electric steel, the tonnage of which during the past four years has shown a remarkable increase not only in the United States but throughout the world. This has been brought about for two important reasons, first, the higher quality which can be made by use of the electric furnace, and second, the lower cost of operation shown in most cases as compared with the previous method of manufacture.

The meeting passed resolutions inviting all manufacturers of electric furnaces, electrical apparatus, electric furnace supplies and accessories, public utility corporations, designers and inventors of electric furnace equipment, and the users of electric furnaces to become members and to join in making an aggressive and thorough campaign to disseminate to engineers and to the public accurate data as to the quality of electric furnace products of all kinds.

A splendid start was made in an organized way to carry out these plans. The meeting was attended by representatives of a large number of companies representing manufacturers of electric furnace equipment, accessories, utilities, supplies, designers and inventors, and manufacturers of electric steel.

It is quite likely that the next meeting will be held in New York City the early part of April, at the same time as the Spring meeting of the American Electro-Chemical Society.

The Association of Railway Electrical Engineers

The Association of Railway Electrical Engineers will hold its semi-annual meeting at Atlantic City on June 23. The headquarters of the meeting have not yet been definitely decided upon but it is very probable they will be at the Hotel Denis. More complete information concerning this meeting will be published in a subsequent issue of the *Railway Electrical Engineer*.

PERSONAL

L. D. Smith, chief electrician of the Kansas City Terminal railroad with office at Kansas City, Mo., has left that company to become chief electrician of the Silvis shops of the Chicago, Rock Island & Pacific at Silvis, Ill.

James L. Boyd, division electrician of the Central division of the Northern Pacific railroad with headquarters at Glendive, Mont., has entered the employ of the Chicago, Rock Island & Pacific as division electrician of the El Paso division with headquarters at Liberal, Kan.

E. C. Cherrington and T. R. Cooley, who for the past few years have been in the sales service department of The Cutler-Hammer Mfg. Co. at Milwaukee, have been transferred to the Pittsburgh office of the Central District, Mr. Cherrington becoming office manager and Mr. Cooley engineering correspondent.

Everet G. Perkins, for a number of years in the employ of the Minneapolis, St. Paul & Sault Ste. Marie railroad as electrician in the Minneapolis terminal, has given up that position to take up agricultural work near Guthrie, Ky. Mr. Perkins leaves a wide circle of friends, who, with his fellow employees, regret to part company with him. N. H. Bidleman is temporarily filling the position vacated by Mr. Perkins.

W. S. Couch has been appointed electrical supervisor on the Cleveland, Cincinnati, Chicago & St. Louis with headquarters at Indianapolis, Ind. R. D. Morgan has been appointed electrical supervisor with headquarters at Bellefontaine, Ohio, and Walter Ryan has been appointed electrical supervisor with headquarters at Mt. Carmel, Ill.

George K. Heyer is the new assistant telephone sales manager of the Western Electric Company having been advanced from the position of railway sales engineer. He has been an employee of the company since 1902 and always has been in New York. He will remain there as his headquarters will be at 195 Broadway. E. V. Adams succeeds G. K. Heyer as railway sales engineer of the Western Electric Company. He has been a West-

ern Electric man since 1910 when he began in the railway sales department of the Chicago house. He was transferred to St. Louis in 1912 and the following year went to New York where his headquarters will remain.

LEONIDAS D. MCDONALD was appointed assistant division operator of the Maryland division of the Pennsylvania Railroad with headquarters at Wilmington, Del., effective March 16, 1919. Mr. McDonald was born in November, 1872, at Newark, Del. He was educated in the public schools and a private school at Newark, and later attended the Newark Academy. In July, 1890, he entered the employ of the Philadelphia, Baltimore & Washington as a telegraph operator; in September, 1906, was appointed assistant manager of the general telegraph office, being promoted to manager of this office in September, 1910, from which position he was appointed assistant division operator on the Maryland division of the Pennsylvania, as noted above.

TRADE PUBLICATIONS

The Trumbull Electric Manufacturing Company has sent out notice that they have discontinued the sale of insulating joints and hickeys. All orders now in their factory will be filled but no further orders can be taken.

The Fafnir Bearing Company, New Britain, Conn., is distributing its monthly house organ, The Dragon, for March. In this month's issue is some interesting data concerning the use of ball bearings in the war and also a very good description of the Bessemer process for the manufacture of steel.

The Esterline Company, Indianapolis, Ind., is distributing a four-page envelope folder entitled "Power Factor Surveys" in which is pointed out the advantages of keeping a power factor record. Some interesting power factor curves are shown together with the illustrations of the power factor meter manufactured by this company.

Electric Industrial Trucks.—Three types of electric industrial trucks designed for different services, including a carrying truck, an elevating platform truck and a tractor, manufactured by the Buda Company, Chicago, are described in its bulletins, 327, 328 and 329, respectively. These give a general description of the construction and specifications for each type, as well as illustrations and drawings. Bulletin 326 contains a brief description of the mechanical features common to all three types.

The Ohio Brass Company, Mansfield, Ohio, has recently issued its catalogue No. 17, listing high tension porcelain insulators, overhead materials, rail bonds and car equipment specialties. The book is bound in cloth and contains 672 pages. The apparatus listed is well illustrated with many photographs and drawings. In addition to the regular classified index in the back part of the book, a convenient thumb index is provided, making it an easy matter to locate quickly any of the material listed.

Electric Arc Welding & Cutting Company of Newark, N. J., announces in a small folder the opening of a school for the purpose of giving instruction in welding. Both day and night classes will be organized. The day classes are intended for those wishing to give their entire time to the work until the course is completed. The night sessions will be open for two classes, one, Monday, Wednesday and Friday nights from 6:30 to 9 o'clock; the other class on Tuesday, Thursday and Saturday at the same hours. A tuition fee will be charged for these courses.

The National X-Ray Reflection Company, New York-Chicago, has issued a 246-page book, 8 in. by 10 in., bound in cloth, which is an exposition of the manner of lighting all kinds of interiors by the use of the X-Ray reflectors. This matter is divided into chapters dealing with such subjects as illumination from concealed sources, control of light, indirect lighting, direct lighting, etc. In each case general principles of illumination involved are presented first and followed by an explanation of the special application of the X-Ray equipment. A considerable portion of the book is devoted to descriptions of a large number of actual installations.

"The Crescent Principle of Belt Joining" is the title of a four-page bulletin issued by the Crescent Belt Fastener Company, New York, describing the fasteners made by this company for joining all kinds of belting. These are claimed to give a flush joint, allowing the belt to have continuous contact with the pulleys. Several illustrations show completed joints with the various kinds of fasteners. The method of making the joints is also explained and illustrated. A ready reference chart, by means of which a belt man or machinist can readily determine the correct type of belt fastener to use for any condition of service, is included in the bulletin.

C.-H. Molded Insulation is the title of a new two-color 16-page 8-in. by 10½-in. booklet which describes Thermoplax and Pyroplax, the trade names of the heat resisting and fire resisting insulations made by The Cutler-Hammer Mfg. Co. of Milwaukee, Wis. Numerous photographs illustrate over two hundred different pieces molded from these materials within the last fifteen months. They include such pieces as attachment plug and cord connector parts, heater connectors, ignition wire spacers, switch and starter bases, stove, hot plate and heater bases, marine wiring devices, switch and rheostat handles, radiator caps, and a large difficult piece to mold—a 24-in. field rheostat base. The booklet gives the physical properties and characteristics of these two materials and describes the method of manufacture.

Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., has issued a complete catalogue in which all of their electrical supplies are listed. In compiling the catalogue every effort was exercised to make it of convenience to purchasers.

The catalogue is made up of 1264 pages of description pertaining to the products of the company and a score of other pages contains a complete cross index, and index to style numbers, and a table of "Approximate Cost Multipliers," which enables one to figure the approximate cost of all supplies listed.

Although the book is called a catalogue, it contains much information of a technical and engineering nature. Practical suggestions for the use of many kinds of apparatus for the transmission and utilization of electric power are given. It is planned to issue this catalogue annually.

Railway Electrical Engineer

Volume 10 May, 1919 Number 5

OUR CINCINNATI OFFICE

The Simmons-Boardman Publishing Company, publisher of the *Railway Electrical Engineer,* has opened an office in the First National Bank Building, Cincinnati, Ohio. It will be in charge of R. H. Smith, a member of the business staff formerly connected with our Chicago office, who will look after the interests of the Simmons-Boardman publications, including the *Railway Electrical Engineer,* Railway Age, Railway Mechanical Engineer, Railway Signal Engineer, Railway Maintenance Engineer and the Locomotive and Car Builders' Dictionaries.

WHY ELECTRIC TRACTION MUST INCREASE

Electrification is properly looked upon as an improved method of operation and any improvement which affects the public generally is certain to receive a large share of attention whenever discussed. It is quite likely that this very popularity has been the cause of much irresponsible talk concerning this important development and has given rise to some very absurd statements with reference to its ultimate growth.

There is but one test that can be properly applied to determine whether any expense is justifiable and that is to carefully weigh the resultant advantages against the disadvantages, these terms being used in their broadest sense. Although the matter of expense alone may be the determining factor which will prevent the adoption of electrified lines, in many instances there are other factors which complicate the problem considerably. For instance, there are cases where as a simple motive power proposition electrification could never be justified, but when the resulting advantages were taken into consideration, such as the elimination of smoke and the consequent increase in value of property adjacent to the road, it was found that electric motive power was the more economical means.

Generally speaking, the volume of traffic is the chief factor in determining whether or not electrification is practical. In making the study the fact must not be lost sight of that the amount of power derived from a pound of coal burned at a central power station is considerably in excess of that obtained by the best possible steam locomotive performance; this means that millions of tons of coal are consumed needlessly. While on a strictly cost basis this is apparently justified, it is a serious mistake to overlook the fact that our coal supplies are becoming yearly more difficult to mine and that in consequence coal, itself, is becoming more and more costly. Although our coal sources are vast, indeed, when once they are gone they can never be replaced. The present generation will not feel, of course, any marked change in coal supply, nor will several generations to come, but that is no argument why we should permit our water power resources to be wasted year after year. These sources of power must be and will be developed without too much consideration being given to the actual cost of coal at the present time. The conservation of coal is a most important matter and one which will be given much attention in the next few years. Ways and means will be developed to use it most economically and one of the greatest savings in this direction lies in a more extensive use of heavy electric traction.

THE QUESTION OF PRICES

There is probably no other single matter that is responsible for so much hesitancy and stagnation in the industries today as are the prevailing high prices throughout the markets of the world.

After the signing of the armistice there appeared to be a very general opinion that the greatly increased cost of materials which obtained during the war would meet with marked and rapid reduction, but now after a period of six months it is becoming more and more apparent that pre-war prices will never return. It is true that small reductions have been made in some articles, but for the most part these form such an insignificant portion of living expenses that they are unworthy of further consideration. There is a feeling more or less prevalent throughout the country that the final signing of peace terms will stimulate greater industrial activity and it is quite possible that such will be the case, but there is, however, little or no grounds for assuming that there will be any marked reduction in prices.

As the cessation of hostilities had practically no effect on the prices of raw materials and the commodities it is very doubtful indeed if the official ending of the war will produce any marked change. If this is so, then we must look further for the underlying causes of the existing high prices. A careful analysis of the subject develops the fact that high prices are not confined to any one nation or group of nations but are world-wide in extent. Further evidence that the war alone has not been responsible for high prices is seen in the increased cost of many products, non-essential for war purposes, which originated in countries far from the seat of war.

When the war opened and prices began to rise the

cause was obviously the great demand, and resulting scarcity, for materials needed in carrying on warfare. So much material was drawn from the peace time industries that this scarcity is still a large factor. Quickly following this demand was the enormous increase in the amount of paper money issued. During the four years of war the face value of paper currency issued was greater than the value of all the gold and silver mined in the world since the discovery of America. Approximately $36,000,000,000 in paper money has been issued by fifteen responsible governments of the world. This paper currency, while representing the promise of the governments to pay, has been issued with a relatively small percentage of gold as a basis. The inevitable result in such instances is the rapid depreciation from the face value of the currency. To say that prices are high is simply another way in saying that money has depreciated in buying power.

If this analysis is correct and the enormous increase in currency is largely responsible for the advance of prices, is it to be expected that there will be any marked reduction until the cause of this inflation is removed? The official estimate of the financial budgets of several of the largest countries show an increase of four to six times to those of the pre-war period. This being the case, it is scarcely to be expected that these governments will be in any haste to reduce the oversupply of currency and it would be futile to look for any marked lowering of prices for a long time to come.

CAR LIGHTING IN THE YARDS

Mention of the name "car cleaners" at a car lighting association meeting invariably causes a murmur from those present indicative of a certain amount of feeling. There is a feeling between the two factions which if done away with would not only improve conditions in the yards, but would improve the quality of electric train lighting.

Good lights are essential to good service. Car cleaners must have lights for their work, but if they use all of the lights in a car and leave them burning after they have finished their work, as is frequently the case, it reduces the charge in the battery. Lights are best with the battery fully charged and if the cream of the lighting is used by the cleaners the traveling public is obliged to take what is left. Porters are also common offenders. When the weather is warm they pull down the shades of a car standing in the yards so the sun will not shine in and overheat the car and then turn on the lights. The bad effect of using the lights in this way applies particularly to the straight storage systems, but it also has its effect on cars equipped with axle generators. In the latter case, when the battery is run down the passenger has poor lights when the train is standing or running slowly, and good ones when running fast. This applies particularly to trains in local service. Furthermore, lights supplied with energy from batteries cost more to operate than those used in the yards of buildings, but few people make any recognition of this fact.

Many efforts have been made to rectify this condition. In one case the car lighting foreman took out all the fuses on the cars except those on one circuit in each car. The cleaners promptly collected the fuses, a pair from each car, until they had enough for all the circuits in one car and then proceed to take these with them from car to car. In another instance when a car lighting man concluded that the cleaners were using the lights wantonly he pulled the main fuse under the car. A few minutes later he returned to find the lights all burning in the car, a train connection having been used to take power from the adjacent car on the train. Such methods cause friction and should not be resorted to. Some sort of portable light for the cleaners has been proposed which may in some cases solve the problem. A mutual understanding between the forces or factions of cleaners and car lighting men will go far to improve the service and a little effort in this direction will net profitable results.

THE ATLANTIC CITY MEETING

It is not too early to make your plans for attending the semi-annual meeting of the Association of Railway Electrical Engineers on June 23, at Atlantic City. The fact should be kept in mind that Atlantic City is the Mecca for conventions at this season and hotel reservations should usually be made in advance if any really desirable accommodations are to be expected.

Now that the war is over we can give our undivided attention to matters which, of necessity, have been more or less slighted during the past two years. The semi-annual meeting, while brief as compared with the annual convention, is nevertheless an important factor in the development of the association. An opportunity is presented for an interchange of ideas not only by open discussion during the formal meeting, but at many private "confabs" which are inevitable in a gathering of men engaged in the same kind of work. The benefit derived from these impromptu group gatherings is difficult to estimate, but there is no doubt that it is a real and valuable adjunct.

The purpose of the meeting is to discuss the progress reports of the various committees assigned to the subjects to be presented at the annual convention in October. Preliminary discussion of the several topics affords an excellent opportunity for constructive criticism which serves to guide the several committees toward a more comprehensive treatment of their respective subjects. Association members should come prepared to discuss the various phases of the problems with which they are contending. At the present time these problems are many, but an earnest and conscientious preparation for their discussion will go far toward making the semi-annual meeting this year the most successful ever held.

In addition to the associations' activities it is well to remember that other railroad associations are also planning to hold their meetings at this season. The meeting of the Master Mechanics' Association and the Master Car Builders' Association, as well as that of the Railway Supply Manufacturers' Association, will be held between June 18 and June 26. In connection with this latter association will be the exhibit of numerous railroad appliances. The space already reserved for this purpose is greatly in excess of that reserved for any previous year. This fact may be taken as a sure indication that the exhibition of railroad apparatus this year will far exceed in extent and completeness any similar exhibition heretofore held.

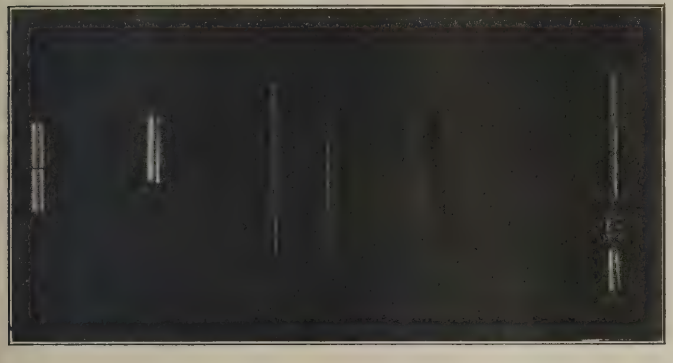
How Incandescent Lamps Are Manufactured*

An Insight Into the Operations Required in the Production of This Common Lighting Unit

WHOEVER has not seen the operation of a lamp factory should think of large numbers of small parts, bits of very fine wire, little pieces of glass and metal which are fused together in the process of making lamps. He should think also of accuracy of measurement in reference to the filament or glowing element of the lamp, and of frequent assorting into sizes of the glass parts.

The Filament

Raw oxide of tungsten is purified by the lamp manufacturer and reduced to metallic tungsten powder—the particles of which are sintered together in the electric



Tubing, Flare, Cane, Arbor, Lead Wires and Stem

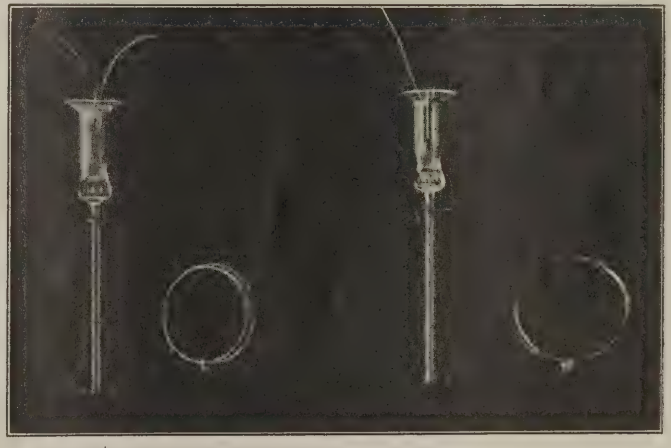
furnace at high temperature. The slug so formed is reheated and worked by repeated hammering, into a long rod, which is then drawn out by passing it through hard dies of successively smaller sizes until, if required, a wire is secured that is only a few ten thousandths of an inch in diameter but many thousand feet long. This wire has a greater tensile strength than steel and is extremely refractory. It is wound on paper spools with its coils overlapping in a manner which prevents tangling, and is carried in stock in this form. When mounted inside a closed bulb from which all active oxygen has been removed, this fine filament of metal will withstand the heat of incandescence, giving off light of excellent quality.

The trade demands a standardization of the quantity of light, the consumption of electrical energy, and the voltage at which lamps will operate. The limits of permissible variation are narrow. It is necessary, therefore, for the manufacturer of lamps to control the sizes of filament very carefully both as to diameter and the length to be mounted in a lamp of required wattage and voltage. A commercially operated micrometer caliper will not record variations of diameter in the small sizes involved, with sufficient accuracy, but by weighing uniform lengths of filament on a sensitive torsion balance, which can be operated rapidly and with precision, the manufacturer does control filament diameter within the narrow limits required by the specifications.

After the filament wire is sized, it is coated with a chemically compounded substance which assists in freeing the bulb of active oxygen in a later operation. As the coat is applied, the wire passes through an oven which dries the filament and permits immediate re-spooling. The torsion balance again plays its part in checking the uniformity of the coat. The chemically treated filament is delivered to the mount department, where it is wound on a form which is adjustable and is set so as to define in millimeters the length of filament, to be mounted in each lamp.

The Support

The materials to be used in making the support for the filament are cane glass, stem tubing, and a pair of small leading-in wires of an alloy having the same coefficient of expansion as glass. The stem tubing is assorted as to outside diameter and classified into several classes of narrow limits. Each of these classes is then assorted on the basis of thickness of the tubing wall. It is not essential that pieces of glass of the same diameter and wall thickness be made up into lamps of the same wattage or type, but it is essential, when working glass, that the pieces are about the same weight and will be acted upon by the gas fires in manufacture at about the same speed. It is for this reason that the assorting is made carefully. The pieces of tubing so assorted are then cut up into lengths suitable for each type of lamp, ranging from about one inch to two inches long, by being held against a sharp edged carborundum wheel. The combination of the scratch made and the heat generated is sufficient to make



Inserted and Mounted Stem; Coil of Hook Wire; Coil of Filament

a clean smooth cut, the tubing parting at the scratched place.

Cane glass about an eighth of an inch in diameter is assorted in a similar manner and is likewise cut into suitable lengths.

The tubing is flared at one end by means of automatic machinery, little buttons are formed on the cane, and the two together, with a pair of leading-in wires, are fused into a seal. The three parts thus joined are known as a stem. In another automatic machine operation, support-

*An abstract from an article published in "The Wisconsin Engineer," by H. M. Robins, superintendent of the Westinghouse Lamp Company, Milwaukee, Wis.

ing wires are inserted into the two glass buttons. These wires are in the form of hooks and supply the support for the filament. The inserted stem is mounted on a metal tray having 100 pegs, and eight of such trays, capable of holding 800 inserted stems, become the unit from the standpoint of handling. This unit is delivered to the mounting department where eight forms of filament, mounted as described above, are included with the unit and delivered to the mounting operative. The eight forms of filament contain sufficient wire filament for eight hundred mounts.

Mounting the Filament

On receipt of this material, the mount operative unwinds the filament from the form, winding it on the supporting wires on the inserted stem, and clamps the ends, by means of a powerful foot clamp, to the upper ends of the two leading-in wires. The inserted stem is then called a mount and, as wound, is transferred with ninety-nine of its fellows to another tray, replaced in the buss with seven more trays, and delivered to the sealing department.

The Bulbs

Before the mount can be sealed into a bulb, it is well to consider briefly the preparation given to the bulb preliminary to this operation. Bulbs are purchased, much the same as bottles, from the glass maker. They are delivered in hampers containing approximately five hundred bulbs,

Etched Bulb; Top Tube and Tubulated Bulb

each carefully wrapped and packed in tissue paper. After unwrapping and as a part of the same process, each bulb is passed through a sand blasting machine which mechanically etches the trademark on the side of the bulb. They are then deposited in a tray having twenty-five or fifty holes, depending upon the size of the bulb, and transported on a conveyor to a set of washing tanks where the entire fifty bulbs are locked in a tray and immersed in water. As the water bubbles out of the bulbs, it carries with it any dust or foreign matter which may be inside of the bulbs as a result of shipment. For convenience in transporting, the trays of bulbs are stacked one on top of the other six high and are delivered to another room known as the tubulating department.

Here a hole is punched in the smooth end of the bulb by directing against this point an extremely sharp, round flame until a small circular section is heated. By blowing low pressure compressed air through the inside of the bulb, a hole is blown outward, leaving a small flared edge at the heated point. To this edge is fused a small tube about two inches in length and perhaps a quarter of an inch in diameter. It is through this opening that the bulb is later exhausted and it is near the point of fusion that the tip of the lamp is made after the air has been exhausted. The bulbs so tubulated are mechanically con-

Tubulated, Cracked Off, and Sealed In Bulb

veyed to the sealing department ready to be sealed over the mounts which are constantly being supplied by the mounting department.

Sealing the Bulb

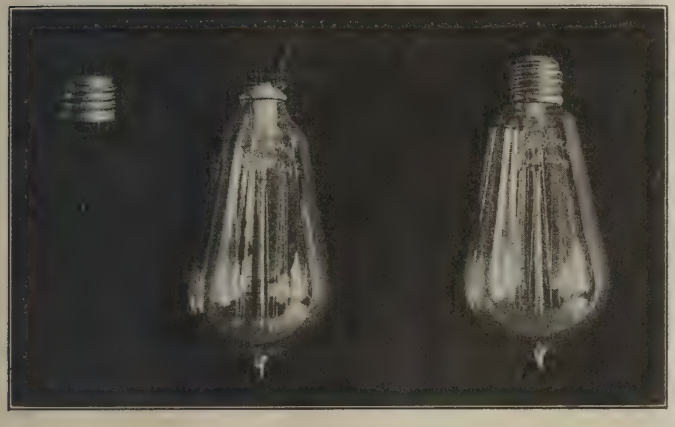
The sealing operation also is automatic. The mount and bulb are placed on a machine in separate holders which, however, revolve about the same axis in synchronism, the mount being properly located inside the bulb. In the operation of the machine, the revolving lamp parts are subjected to small but very hot gas fires which melt down the neck of the bulb until it joins on to the flared end of the mount. The two are sealed together at this point of contact and the portion of the bulb beyond the seal which is superfluous is melted off and removed, after which the operative removes the lamp, and, while it is still hot, straightens the mount in the center of the bulb, by hand.

Exhausting the Bulb

The lamps are then drawn in stacks of three hundred, into the exhaust department, where they are subjected to vacuum pumps and mechanically exhausted to a degree requiring a gauge reading in ten thousandths of a millimeter of mercury to indicate it accurately. During the time that the lamps are being exhausted, the bulbs are also being heated to a temperature almost sufficient to melt the glass. This is to insure any small amounts of moisture being changed to superheated steam so that it can be withdrawn from the lamp.

An interesting point in connection with the exhaust is

the fact that it is absolutely impossible to exhaust completely a globe of this kind by mechanical means since, on each stroke of the pump, the atmosphere inside the bulb is rarified but not completely withdrawn. After this process has been repeated for some minutes, the air remaining in the bulb is extremely rarified but there is sufficient oxygen, either in the form of free oxygen in the air, or combined with moisture, to be a source of trouble during the burning life of the lamp. However, since it is impossible to exhaust the lamp completely by mechanical means, the operative, at the end of a predetermined schedule, tests for degree of vacuum, and, if this is satisfactory, heats up the little tube at a point adjacent to the bulb, and seals off the lamp at this point. The tip of the lamp, with which everyone is familiar, is evidence of this operation.



Exhausted Lamp, Unbased and Based

Flashing

The flashing operation, which is really a part of the exhaust, is the first operation in which the filament is subjected to electric current. In this operation, the lamp is put in series with a constant resistance. The lamp itself has a varying resistance inasmuch as its resistance cold is probably less than one-tenth of its resistance when heated. The total resistance of this series circuit, whether the lamp is cold or hot, is sufficient to prevent a too excessive rush of current through the lamp which is still incompletely exhausted and which might otherwise burn out. As the current flows through for the first time, certain gases in the filament and in the chemical coating, are set free. The damaging portions of these gases which tend to deteriorate the filament, together with such oxygen as may have been left in the bulb after the mechanical exhaust, are combined with certain elements given off by the chemical with which the filament was coated. The resulting compounds are probably in the form of minute quantities of powder which are invisible to the eye, also some neutralized gases in small quantities which have no oxidizing effect on the filament. After the lamp is flashed and all gases neutralized, it may be safely subjected to the voltage for which it was designed.

Basing and Inspection

The remaining operations in the manufacture of the lamp are basing and final inspection. The basing operation consists of cementing onto the neck of the lamp a base to whose terminals the leading in wires are soldered. This base makes the lamp convenient for general use. The lamp is then given a rigid inspection for mechanical defects, cleaned, labelled, and packed in cartons, ready for shipment.

Automatic Machinery

The use of automatic machinery in connection with lamp making is increasing every year. Mechanical engineers of high order are constantly working on the problem of developing machinery to combine operations and facilitate handling of material. The nature of the work is such that nearly all of this development has been done by the lamp manufacturers, whose engineers see the possibilities and think them through to completed solutions. With the increased use of automatic machinery, the problem of maintenance has brought about, more clearly than before, the realization that good work cannot be done with poor tools and that machines must be kept in continuous and perfect repair if manufacture is to continue uninterrupted and at a low cost.

THE AMPERE-HOUR METER REDUCES MAINTENANCE AND OPERATION EXPENSES

It is a well-known fact that lead storage batteries require the best of care in order for them to give efficient service. The charge and discharge must be controlled as accurately and intelligently as is practical, otherwise the service will gradually become less efficient and eventually individual cells will break down, with the ultimate result of complete failure. Various methods of controlling the charge and discharge of such batteries are in use and the success of each depends largely upon the method itself and how it is handled. In some cases a change of method may result in considerable saving. For instance, one road effected a saving of several thousand dollars annually by installing an ampere-hour meter in connection with the charging of a 1600-ampere-hour, 240-volt storage battery at one of its lift bridges. One of the illustrations shows graphically the exact conditions existing at that point for a period of three years (1915, 16 and 17). The curves were plotted from data collected during those years, with the cost of current, kw. hrs., partial and full lifts, as ordinates, and with the months of the year as abscissa.

A year or so after the bridge was put into operation it was thought by those concerned that the cost of current was excessive, and that the battery required unusual attention, repairs and renewals. This was perhaps largely due to its being overcharged, as the motor generator set used for charging purposes was frequently allowed to run and to dissipate its generated energy into the overcharged battery. To determine more definitely what the exact conditions were a study of the situation was begun. Curves were plotted from the data collected for the various factors mentioned above. Surprising and varied results were obtained from month to month during 1915 and part of 1916, all of which pointed to the fact that the batteries were being overcharged, which meant wasted current. Besides that the cells were naturally being used up, due to this continuous overcharging.

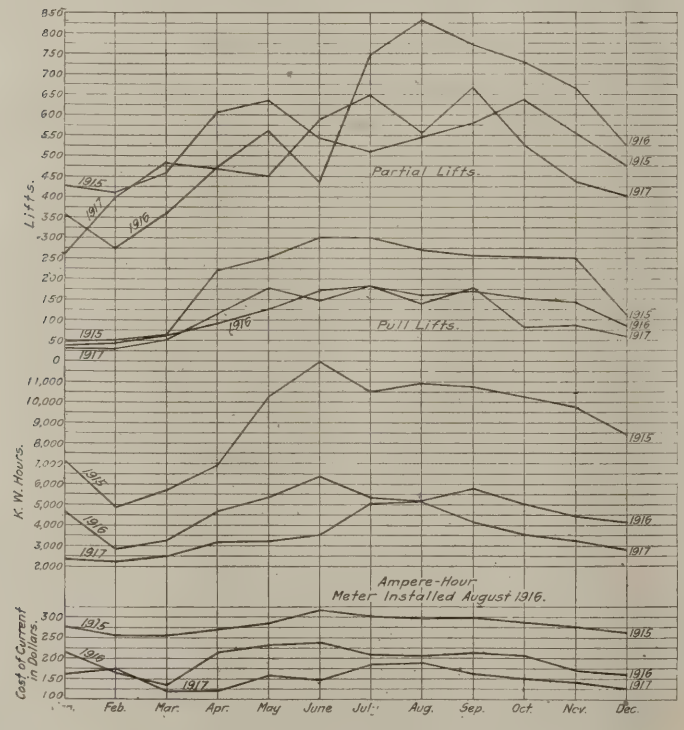
To overcome these conditions an ampere-hour meter and a circuit-breaker were installed in August, 1916, at a cost of approximately $125. For the remaining part of

that year and also during 1917 the practice of collecting the data and plotting curves was continued. The results during that period were also astonishing, but more in line with what might be expected. Comparing the figures for 1915 with those for 1917 and assuming the same number of lifts for the latter year as were actually made during the former, the 1917 figures show a saving in the cost of current of about $1,112, or approximately 35 per cent, as compared with 1915. Besides that, there is also a saving in the wages of one of two men, both of whom were employed for charging the batteries. This latter saving in itself, with the present scale of wages, amounts to $1,632 annually, so that the combined saving of current and wages amounts to $2,744. Then there is a further saving of battery repairs and renewals for which no figures are available, but it is said that there have been very few such repairs or renewals since the installation of the ampere-hour meter.

The following table as a summary shows what has been accomplished:

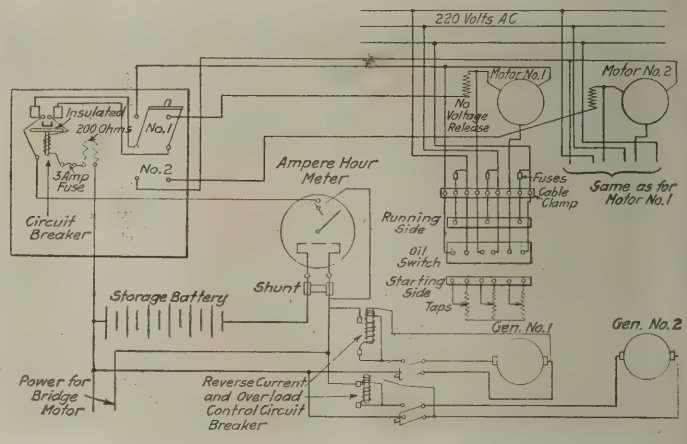
	Year 1915	Year 1916	Year 1917
Total partial lifts for year	6.420	6,994	5,915
Average partial lifts per month	536	583	492
Total complete lifts for year	2,253	1,499	1,146
Average complete lifts per month	187	125	95
Total partial and complete lifts for year	8,673	8,492	7,061
Total kw. hrs. consumed for year	104,656	56,220	39,496
Average kw. hrs. consumed per month	8,804	4,352	3,291.3
Total cost of current consumed for year	$3,237.95	$2.346.87	$1,737.59
Average cost of current consumed per month	$269.83	$195.57	$144.38
Average kw. hrs. consumed per lift	12	6.62	5.59
Average cost of current consumed per lift	$0.373	$0.276	$0.245

The circuit illustration shows the complete general arrangement of the ampere-hour meter, control and charging equipment. The only additions to the original installation are the panel on which the circuit-breaker, and the double pole, double throw knife switch is mounted and the ampere-hour meter itself.



Curves Showing the Actual Operating Characteristics

It will be noted that one terminal of the no-voltage release coils on the starting compensator breaks through one point of the double pole, double throw knife switch for both motor generator sets. The operation is as follows: When about 800 ampere hours are discharged from the battery, the circuit-breaker is closed, and the double pole, double throw knife switch is thrown either in number one or number two position, which closes the circuit on the voltage release coil of the starting compensator. The motor generator set is then started by means of the compensator, and when the proper voltage is generated, the reverse current or overload circuit-breaker is closed on one of the two generators, depending on which one



The Charging Circuits Showing the Ampere Hour Meter

is started. The batteries are then charged at a given rate until the pointer on the ampere-hour meter is returned to zero, at which time the circuit to the coil of the circuit-breaker is opened, which, in turn, opens the no-voltage release coil on the starting compensator, thus stopping the motor generator. About this time the battery current has a tendency to flow into the generator. This causes the reverse circuit-breaker to open, owing to the reverse current in the coil, thus cutting off the power to the motor and the charging current to the batteries. A battery operating under the same condition as exists at this bridge requires about 22 per cent overcharge, which is readily taken care of by the ampere-hour meter.

Carbon manufacturers, as well as manufacturers of dynamo electric machinery, have made numerous tests to determine contact resistances, friction losses, etc., of various carbons. While such tests are of interest, they contribute very little towards the real practical need, namely, a carbon which can stand high current densities and high sparking voltages with small wear.

In order to develop such carbons, it would seem essential to first make tests determining how the carbon wear is affected by current density, sparking voltage and peripheral speed. Present indications are that with many commercial carbons very appreciable densities can be used if there is no sparking voltage, while sparking voltages up to 15 or even 20 volts across the brush cause very little wear at certain speeds, if the current density is low enough.

More data along this line should be of great advantage both to the carbon manufacturer and the designing engineer.

Equipment Designed for Electric Arc Welding*

Describing Types Used in Different Systems Including Operating Characteristics and Circuits

By E. Wanamaker *and* H. R. Pennington

WHEN elecrtic arc welding was first originated, direct current power circuits were used to a greater extent than they are now. The first arc welding was done by inserting a resistance in the supply line having a potential of 125 or 250 volts. Water or grid rheostats were used as resistance. These served to adjust the voltage to approximately the proper value for welding. In this scheme the power wasted was considerable, being dissipated in the form of heat in the rheostat and amounting to from 5 to 10 times as much as that consumed by the arc, when a metallic electrode was used. In certain cases of welding such as electric railway work where the power is taken from a trolley wire through a resistance, approximately 95 per cent of the total power used is wasted. When a carbon electrode is used the power wasted is less since a greater voltage

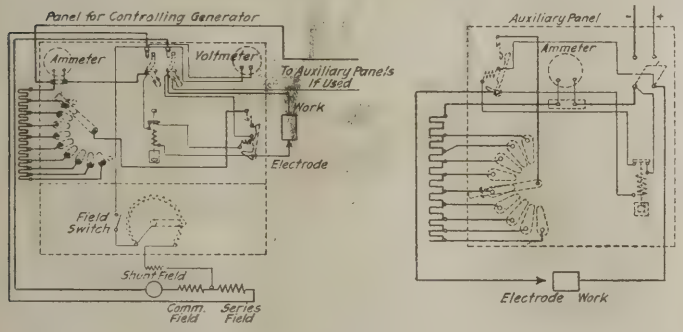


Fig. 1.—Generator Control and Auxiliary Panel Circuits With One Welding Connection on Each

across the arc is required. In spite of the above facts, concerning the waste of power, the saving effected in making repairs in railroad shops by means of electric welding was so great compared to former methods, that the waste was more than offset. This form of an equipment is known as a resistance welder.

Constant Medium Voltage System

In the evolution of arc welding equipment the first step was the introduction of the constant medium voltage type which consists of a motor generator and a control panel. A diagram of connections for controlling a generator and one welding circuit is shown in Fig. 1. The motor for driving the generator can be furnished to operate from either an alternating or direct current power supply at any commercial voltage. The generator is an ordinary compound-wound commutating pole type so designed as to give a constant voltage at all loads. The generator voltage for this type of equipment has been fixed at 60 volts for machines up to 600 ampere capacity. For machines of greater capacity, a voltage of approximately 75 volts is provided. A variation of the voltage will cause a variation of heat in the arc with an attendant irregularity of deposited metal and fusion. The variation should not exceed 5 per cent. An arc welding equipment of this type is known as

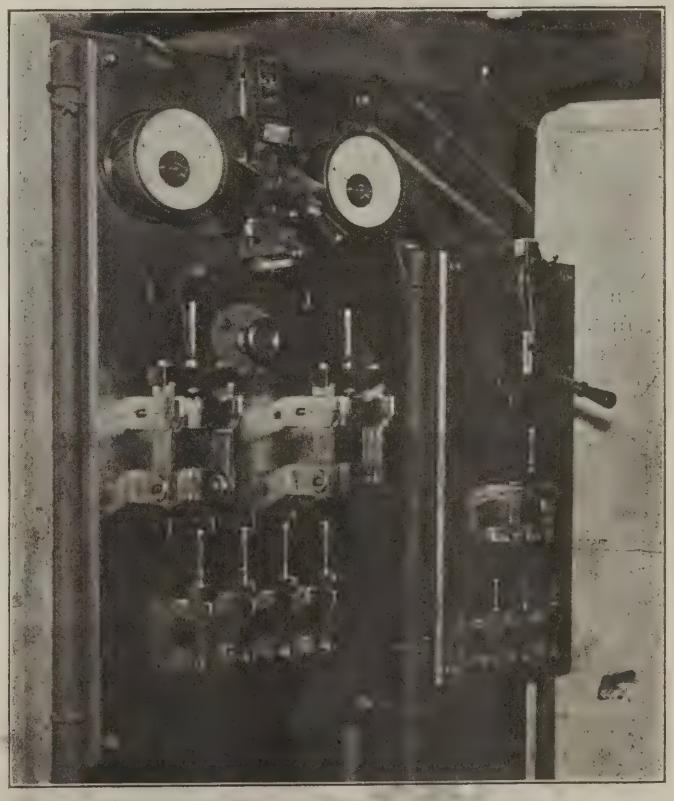


Fig. 2.—Generator Control and Auxiliary Panels

the constant voltage system, and is distinct from some of the recent equipments as more than one operator can work from the same machine. This system has been in general use for some time, usually where a number of operators are working reasonably close together and where both carbon and metallic arc welding is done. When more than one operator is required a control panel is provided for each additional operator. A diagram of connections for the additional or auxiliary panel is shown in Fig. 1. On each panel is mounted an adjustable hand rheostat designed to permit fairly close heat adjustments, a knife switch for disconnecting the panel from the main generator circuit, an ammeter, and, in

*This is the third article on Electric Welding by E. Wanamaker, electrical engineer, Rock Island Lines, and H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines, copyrighted 1919 by the *Railway Electrical Engineer*.

some cases, protective relays and circuit breakers are provided to prevent error in using the resistance and to protect against overloads by short circuit of long dura-

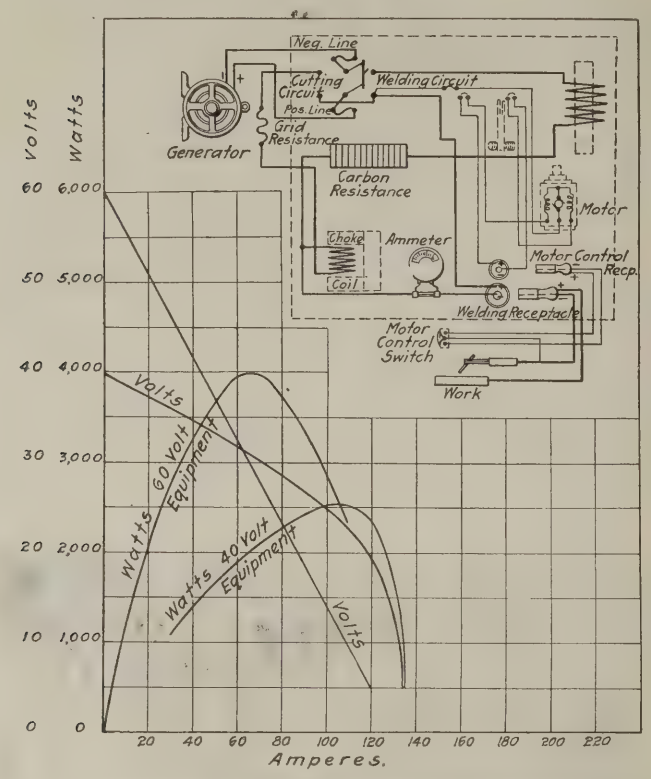


Fig. 3.—Constant Current System Circuit and Characteristic Curves

tion. A view of the generator control and an auxiliary panel is shown in Fig. 2.

The economy of the constant voltage type over the resistance welder is at once apparent because the power

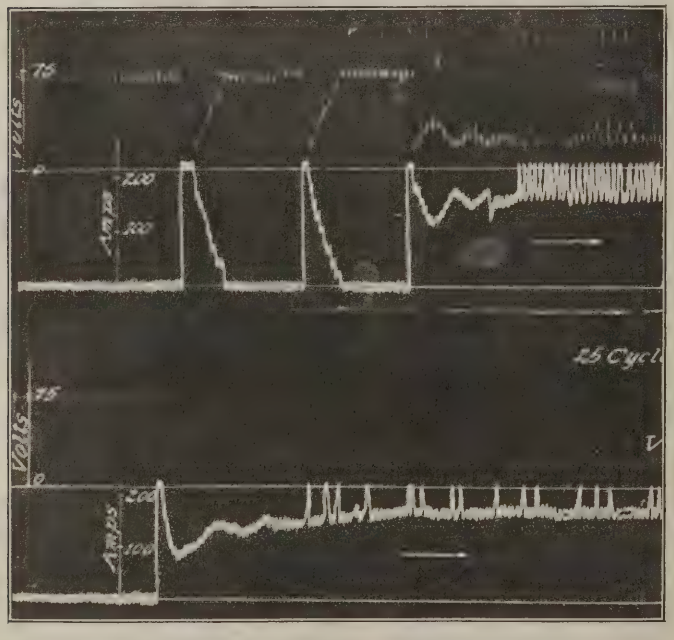


Fig. 4.—Oscillograms Showing Effect With No Reactor in Circuit (upper curve); With Reactor in Circuit (lower curve).

which is taken from the power line is used to operate a motor which drives a generator to provide power for a separate and independent circuit having a medium predetermined voltage value not greater than 60 volts for metallic electrode welding, and 75 volts for carbon electrode welding.

Constant Current System

A modification of the constant voltage system, commonly known as the constant current equipment, or system, is in use in this country. The principal difference in this equipment and the one just described, is that the generator voltage is approximately 40 volts instead of 60, and the resistance in series with the arc is automatically adjusted to a predetermined value each time the arc is established, by means of a carbon pile regulator. The diagram of connections is shown in Fig. 3. The tendency of the regulator is to maintain a constant current within a certain range of arc voltage. Curves of the volt ampere characteristics at the arc, with a con-

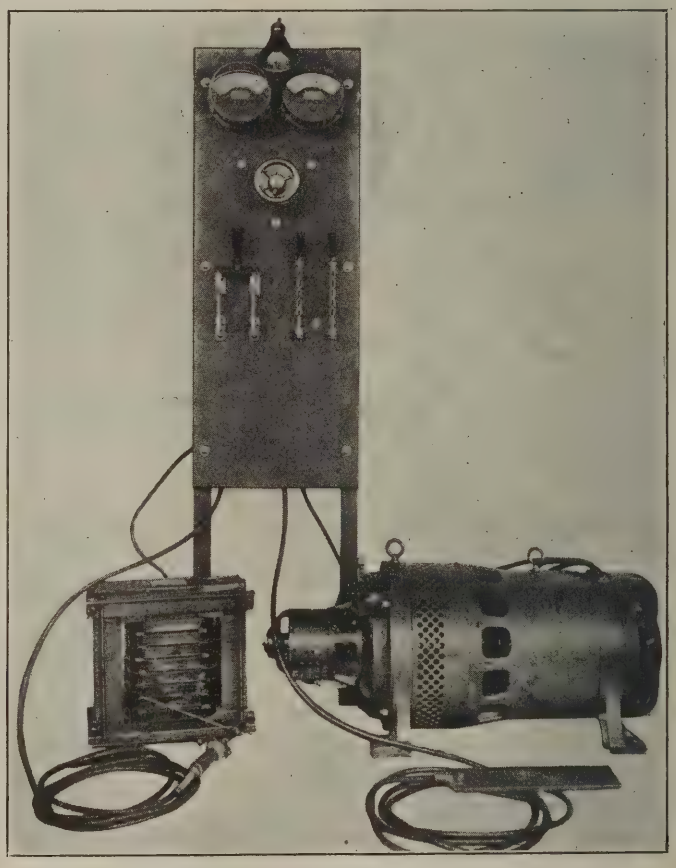


Fig. 5.—The Control Panel, Welding Generator With Motor and Reactor

stant generator voltage of 40 volts and a constant current regulator, also a generator voltage of 60 volts having a fixed resistance in series with the arc are shown in Fig. 3. The 40-volt system has the advantage over the 60-volt system for electrical efficiency. On the other hand the 40-volt system has the disadvantage in that it is more difficult to establish and maintain the arc. Both have their advocates and both are in commercial use. In shops where both systems are in use, the majority of the operators seem to favor the one having the higher voltage.

For either system the workwiseness of the arc can be made very satisfactory by the use of a reactance coil of such capacity as to enable the operator to strike the electrode on the work and withdraw it the proper distance before sticking of the electrode occurs. That a

reactor is effective in service is distinctly indicated by oscillograms, which show the actual characteristics with and without a reactor in the circuit. The upper curve in Fig. 4 was taken with no reactor in the circuit. As a result, the operator was compelled to strike the arc three times before he was able to establish it. This is

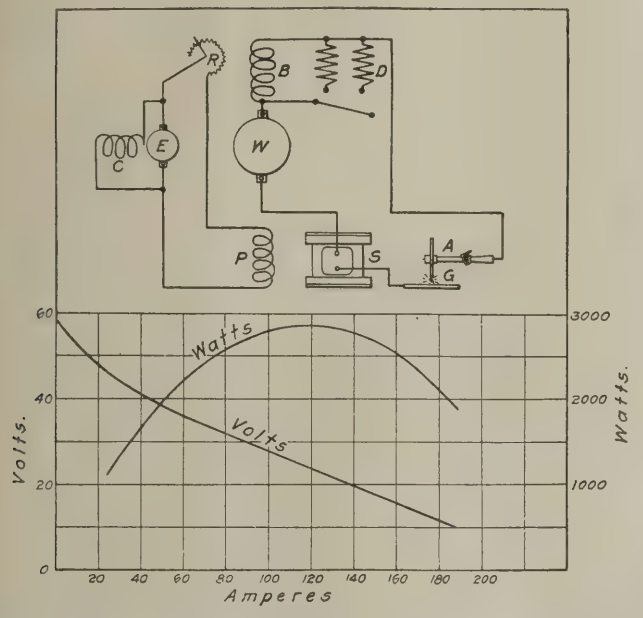


Fig. 6.—One Variable Voltage Type, Circuits and Characteristic Curves

illustrated by the three peak values of current. The lower curve in Fig. 4 was taken with a reactor in the circuit. This curve shows that the current reached the maximum value the instant the arc was struck; however, the length of time that this maximum current existed was so short that there was no tendency for the electrode to

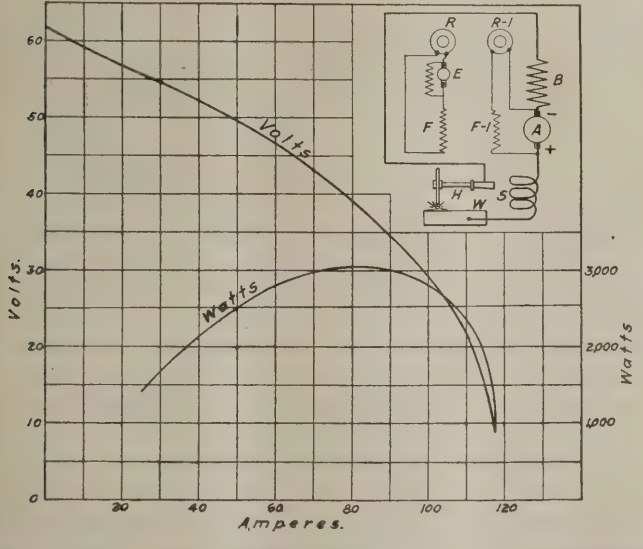


Fig. 7.—Another Variable Voltage Type, Circuits and Characteristic Curves

stick. The reactor also stabilizes the arc and prevents it from breaking when the length is momentarily slightly increased, or when dirt and oxides are encountered. Reactance coils are now furnished with some of the constant voltage systems.

Progress Made in Developing New Equipment

In all the equipment so far described more or less power is wasted because of the resistance used in the welding circuit, so in order to minimize this waste it was necessary to use a voltage as low as possible and still permit welding to be done. This in turn necessitated the use of extra heavy wires for distributing the power to the different stations around a shop or terminal, thus increasing the installation cost to a very high mark providing the system was made flexible, which is necessary if economy in welding is to be fully obtained. Out of this condition grew the demand for an equipment which would be highly efficient, not only for eliminating the power waste, but in order that they would be light enough for portable use when conditions demanded. As a result of this demand there are a number of such equipments now on the market, all of which do good work and meet the requirements to a greater or lesser degree.

The welding equipment problem cannot be solved by any superficial consideration, since there are many conditions to be considered in selecting an arc welding equipment, if good and economical results are to be ob-

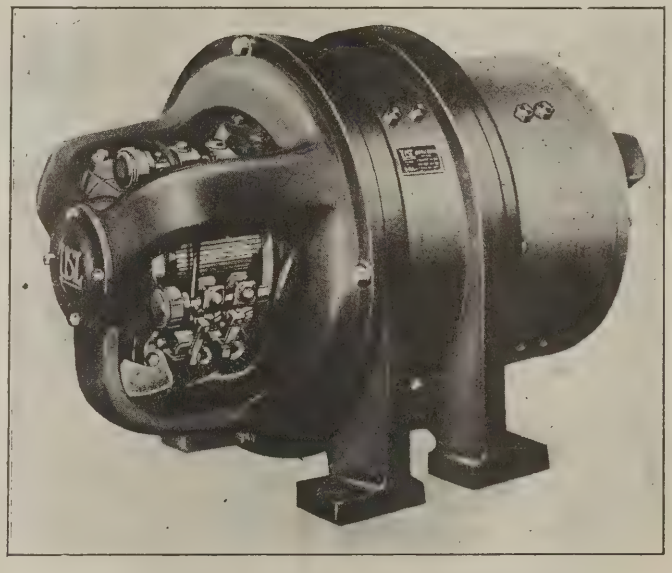


Fig. 8.—A Self-regulating Motor Generator Welder

tained. The subject of arc welding equipment is like many other subjects concerning new and useful appliances which have been developed in the past and upon which many debates were held resulting in a number of alternatives that were equally good. It is therefore the intention of the writers to describe a number of the different equipments and systems with the hope only, that the information will materially assist the reader to wisely select suitable equipment.

Single Operator Variable Voltage Type

The more recent developments have been along the line of single operator equipments having what may be termed self-regulating characteristics. These are more commonly known as the variable voltage type, made so by suitably designed and arranged field and armature windings, in this way eliminating the resistance in series with the arc and increasing the efficiency. Fig. 5 shows a self-regulating, variable voltage, single operator, 150 ampere arc welding equipment. The diagram of con-

nections is shown in Fig. 6. A standard constant speed motor is used for driving the welding generator. Where the power supply is alternating current, a small generator is attached to the armature shaft to provide direct current at a constant voltage for the separately excited shunt field. Where the power supply is direct current the exciter generator is not required, as the shunt field is connected across the power circuit.

The principles involved in the operation of the welding generator includes a separately excited shunt field with a differential compound winding. When the generator is started the voltage is established by the excitation of the shunt field winding *P* and it can be varied by the small field rheostat *R*. When an arc is struck current flows from armature *W* through bucker winding *B;* the bucker being of opposite polarity to the shunt field winding reduces the effective strength of the shunt winding, thus reducing the generator voltage, so as the length of the arc is decreased the current is increased, and vice versa. If the heat or current is not the proper value, when the operator establishes a satisfactory arc length, it may be increased by shunting current around the bucker winding by closing the knife switch which connects shunts *D* in parallel with the bucker winding, or by increasing the voltage with the rheostat, or by both. To decrease the heat this operation is reversed. Fig. 6 also shows curves for the volt ampere characteristics of this type of equipment. The reactance coil or stabilizer *S* is in the arc circuit for the purpose previously stated.

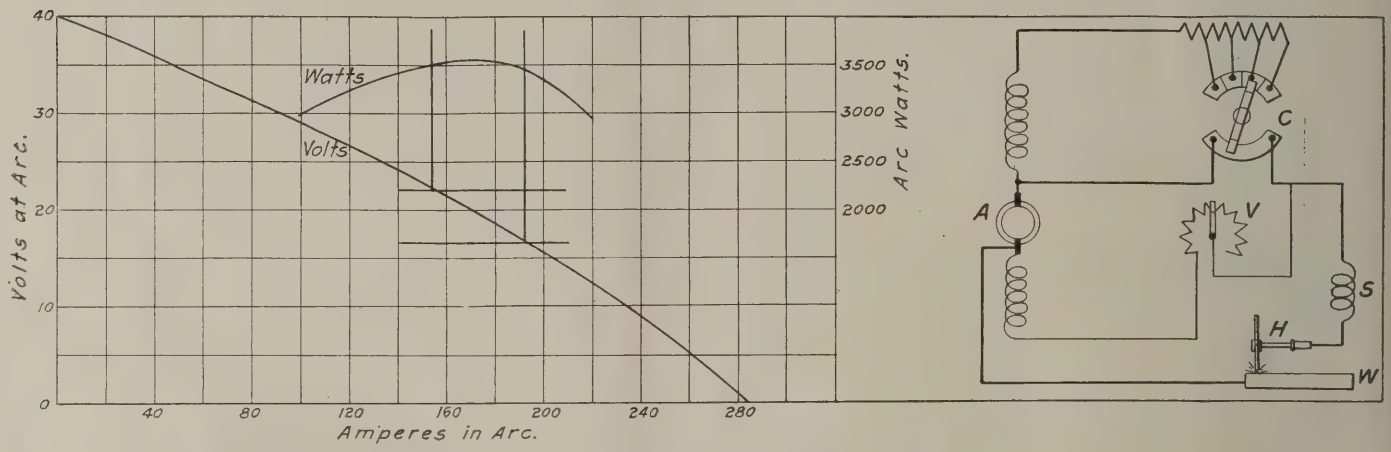


Fig. 9.—Characteristic Curves and Circuits for a Self-regulating Motor-generator Arc Welder.

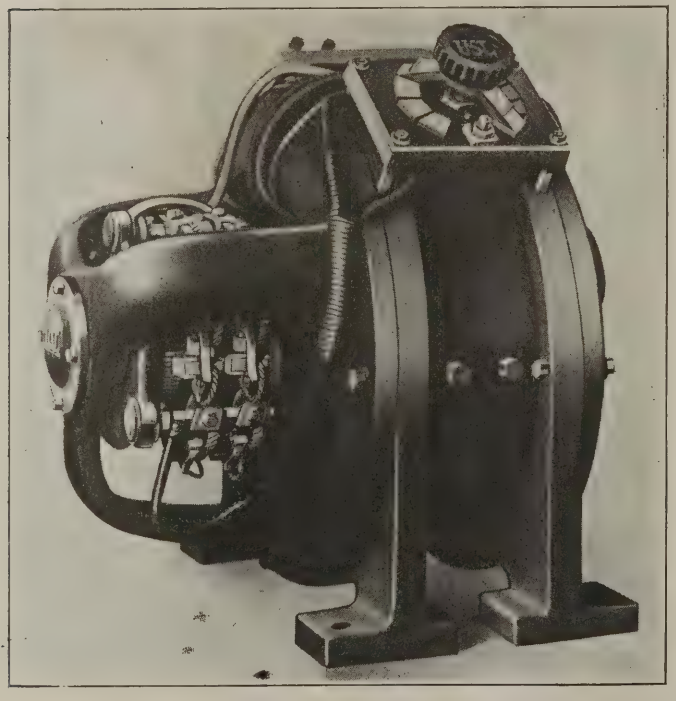


Fig. 10.—A Direct Current Welding Converter

Another equipment similar to the one just described is in use. The diagram of connections is shown by Fig. 7. The shunt field in this case consists of two separate windings; one is self-excited and the other is separately excited. The heat adjustment is made entirely by the voltage rheostats. Referring to Fig. 7 the lettered parts are named as follows: *A*—welding armature, *B*—bucker field, *E*—exciter, *F*—separate excited shunt field, *F-1*—self excited shunt field, *H*—electrode holder, *R* and *R-1*—voltage adjusting rheostats, *S*—reactance coil and *W*—work. Fig. 7 also shows curves for the volt ampere characteristics of this type of equipment.

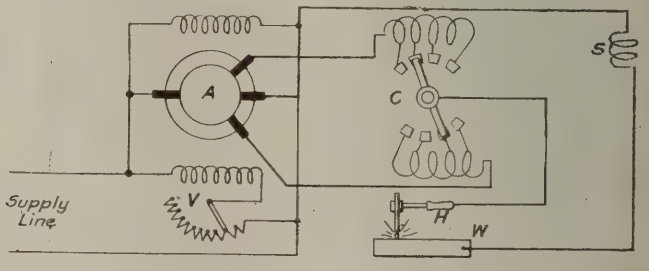


Fig. 11.—Circuits For a Direct Current Welding Converter

The most recent development in the self-regulating type of an arc welding generator is a self excited compound wound type, and is a departure from all previous systems. This equipment is shown in Fig. 8. The driving motor is a standard constant speed motor of from 5 to 10 h.p. rating for metallic arc machines, depending upon the capacity and efficiency of the set. The variable voltage feature in this equipment is accomplished by distortion of the field flux, which occurs when current is taken from the armature by drawing the arc. The diagram of connections for this equipment is shown in Fig. 9. The heat adjustment is made by increasing or decreasing the strength of the shunt field, series field, or both, with the current adjusting switch or voltage ad-

justing rheostat. Referring to Fig. 9 the lettered parts are named as follows: *A*—arc welding generator, *C*—current adjusting switch, *H*—electrode holder, *S*—reactance, *V*—voltage adjusting rheostat and *W*—work. Fig. 9 also shows curves for the voltage ampere characteristics of this type of equipment.

The open circuit voltage obtained from self-regulating equipments usually ranges between 45 and 75 volts. The ampere capacity for metallic arc welding is 150 or 200 amperes and for general work 200 amperes are required. An ampere rating of not less than 300 amperes is required for carbon arc welding. In considering capacity of electric welding generators, it must be borne in mind

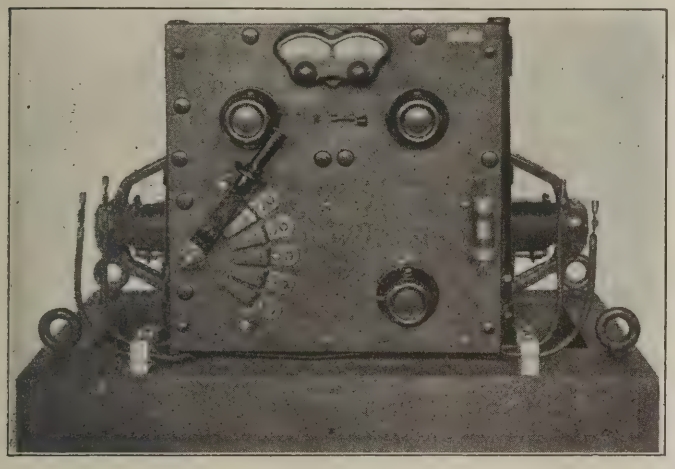


Fig. 12.—Constant Energy Arc Welding Set For Metallic Welding—One-man Portable Outfit, Norfolk Navy Yard

that in speaking of a 150-ampere or 200-ampere rating, as the case may be, it is meant that the generator shall be able to supply the rated current to meet the demands of an experienced operator working continuously, and not necessarily a continuous rate of current flow.

Welding machines may be operated where electric power is not available by driving the generator from any constant speed power source of ample capacity, such as belting to a line shaft, gasoline engine, etc., which permits the application of arc welding at most any location.

Self-regulating variable voltage equipments have been developed for operation from a constant voltage direct current circuit of 125 volts. Fig. 10 shows a welder of this type, and Fig. 11 the diagram of connections. The equipment consists of one armature, one commutator, and one set of fields. One wire of the welding circuit connects to the supply line, the other to an extra brush holder on the commutator. Referring to Fig. 11 the lettered parts are named as follows: *A*—arc welding converter armature, *C*—current adjusting switch, *H*—electrode holder, *S*—reactor, *V*—voltage adjusting rheostat, and *W*—work. This equipment merely provides a lower variable voltage for the welding circuit, and also means for heat adjustment without the use of any series resistance in the supply line or welding circuit; in this way a high efficiency is obtained. This welding machine is known as a direct current welding converter.

Another welding machine which operates from a direct current power supply of 125 or 250 volts is shown in Fig. 12. This welding set also provides a lower variable voltage feature together with means of heat adjustment, without the use of series resistance in either the motor circuit or the welding circuit, resulting in good efficiency. The equipment is simply a balancer set having specially designed field windings; a diagram of connections is shown in Fig. 13.

These equipments are better suited than other types for operation from 125 volts direct current supply, when available. Their use also may prove economical under certain conditions by providing a 125-volt circuit by using a motor generator set, from which a number of converter welders or balancer sets may be operated, or, in other words, any advantages which may have been offered with the old constant voltage multiple operator systems can be obtained with this type of equipment without the disadvantage of having to provide such heavy distributing circuits or to tolerate the heavy loss of power in resistance ballast. Also the bad effects due to the interruption of one operator by another (more or less experienced when more than one operator is working from the same circuit) is almost entirely eliminated, and the saving effected by the use of such a system over the old constant voltage system, would in a reasonable length of time justify the difference in the first cost.

Competitive claims have been made relative to the quality of welds made with certain controls or volt-ampere characteristics, but as a matter of fact exhaustive tests have proven conclusively that if an equipment

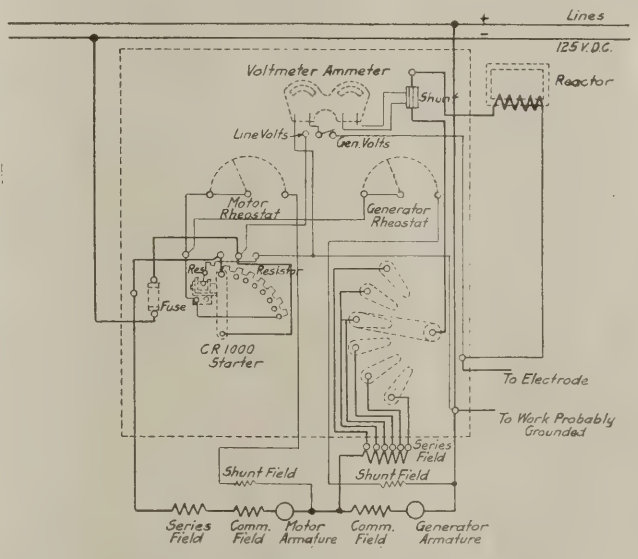


Fig. 13.—Circuits For Equipment Illustrated in Figure 12

provides a work-wise arc, the quality of a weld then depends largely upon the skill of the operator, and to only a very small degree upon any certain volt-ampere characteristics of the control. A study of the curves previously referred to will reveal that about the only difference in the more recent variable voltage equipments and a constant voltage system (where a resistance is placed in the arc circuit) is that the straight line characteristic of the constant voltage welder is approximated by the variable welders. The other merits of the improved equipments, however, are of great value and have been an important factor in furthering the application of the process.

Alternating Current Welding Equipment

Comparatively little welding has been done in this country with alternating current. It has been utilized

to considerable extent in England in connection with coated electrodes. The original equipment consisted of an adjustable ballasting resistance generally constructed for operation from 100 Volts. Recently special welding transformers designed with large leakage reactance have been placed on the market. Fig. 14 shows the general scheme of the reactive method of control. In the operation of this system there is no excessive current because of the high leakage across the magnetic shunt between the primary and secondary winding. On account of this high leakage its power factor is low. Low power factor means excessive primary capacity (of line copper, transformers, generators, etc.). While the first cost of this type of welder itself is lower than welders of the d. c type, yet if the additional capacity for the a. c. welder must be provided for, the cost of the complete installation would be greater than for any other system.

The use of coated electrodes greatly assists in holding an alternating current arc, since the coating tends to exclude the air and prevent the metallic vapor from cooling with each reversal of the current. Where a bare electrode is used it is extremely difficult to start the arc (especially so on cold metal) and it is difficult to sustain the arc owing to the effects of the air each time the

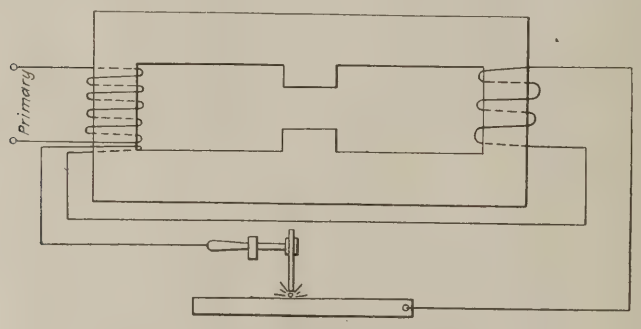


Fig. 14.—Alternating Current Equipment

current reverses. Its field of commercial application will therefore probably be limited to small installations when the excessive primary capacity already exists and for use with coated electrodes.

While there are other makes of equipments of which no mention has been made the ones described represent about all the principal ones commercially used.

Selection of Equipment

In choosing an equipment it should always be borne in mind that the workwiseness of the arc is of primary importance, efficiency following closely. Efficiency can probably best be calculated on the basis of kilowatt hours input per pound of metal melted with the equipment in the hands of an experienced operator. As with all electrical equipment, the safety feature must not be ignored, especially so in the case of electric welding equipments, since they are almost invariably placed in the hands of operators who are entirely unfamiliar with electrical apparatus. The equipment should be so designed that the welding operator will not in any way be liable to injury from direct or indirect contact with the power supply circuit. The local welding circuit to be entirely safe should have a potential as low as consistent for good welding. Past experience has demonstrated that welding equipments now in use which provide a separate and independent local direct current welding circuit are entirely safe, their potential being not greater than 75 volts.

The installation of equipments, including accessories generally used, will appear in the next article.

HOW FRICTION TAPE IS MADE

Although thousands of rolls of friction tape are used by electrical men each year, there are notably few who have seen it made or taken the trouble to investigate just now it is produced. A large manufacturer explains the process as follows:

"Friction tape gets its name from the manner in which the adhesive insulating compound is applied to the cotton cloth, which is called 'frictioning.' The treating compounds vary all the way from a good grade of rubber to ordinary tar; other ingredients are asphalt, reclaimed rubber, and insulating powders, and fillers to give weight. The best grade of new rubber gives good insulating and adhesive properties. Rubber reclaimed from a good grade of rubber has fairly good tape properties, while low-grade rubber, either new or reclaimed, has poor qualities. The addition of substances of an asphalt nature gives durability to a tape as asphalt will withstand conditions of climate and heat better than rubber. An insulating powder is generally included in the compound to give dryness and ease of application.

"There are two ways of applying the compound, one called 'calendering.' This consists of running the cloth between two rollers, one roller running at the same speed as the cloth and the other at a higher rate, thereby tending to rub in or work in the compound under pressure. The compound used in this process is rather dry and forms the insulating base of the tape, giving moisture-resisting and insulating qualities. By this process the compound is forced into the pores of the cloth, thereby making a thin, compact tape, and since the compound is rather dry when worked in and is softened by heat in the rollers rather than by a solvent, the formation of pin-holes by evaporation of solvent is prevented.

"The other process of applying the compound is called 'spreading.' In this process the cloth is run over a roll and under a knife edge, thereby spreading a certain amount of compound evenly over the cloth. The compound in this case must be soft with solvent to spread well, and since it is not under pressure and therefore not forced into the cloth, pin-holes will be formed when the compound dries. When spread on, the compound tends to peel off readily or to stick to the wrong side of the cloth when unrolled, unless it has the calendered compound for a base. This does not give the insulating qualities which are obtained by calendering, but is necessary in addition to calendering to give proper adhesive qualities. It is a poor process except when used in addition to calendering.

"Some tapes are spread only on one side, while better ones are spread on one side and calendered on the other, or, better still, are calendered on both sides and spread on one side. The reason that spreading is done twice on one side rather than once on each side is so that when unrolling, part of the spread-on material will not stick to the wrong side and make an uneven surface. In good tapes the compound does not transfer from one side to another, but adheres to the one side, leaving both sides smooth and even."—*Electrical Record.*

Railroad Electrification Facts and Factors

Pantagraph Shoe Design Is Governed by the Class of Service in Which the Locomotive Operates

By A. J. Manson*

LAST month we took up the design and construction of the pantagraph trolley used for the collection of high voltage current at high speeds. The various parts such as the frame, the insulator, the air cylinder and latch were described in detail. All of the main parts of the pantagraph were covered with the exception of the shoe. This part we will take up this month and show what is essential for the different classes of service, as well as for high voltage alternating and high voltage direct current.

The design of the shoe depends on the class of service in which the locomotive is to operate. If the pantagraph is mounted on a high speed passenger locomotive or multiple unit car, comparatively small currents are required. Where this current does not exceed 100 amperes at starting and is approximately 50 amperes at full speed, the shoe can be made of sheet steel 4 in. wide and ⅛ in. thick. In high speed service, the shoe should be flexibly supported. This arrangement is accomplished by inserting between the shoe and the frame a small pantagraph of only 4 in. to 5 in. high at either end, fitted with light springs which are under compression when the shoe is against the wire. The shoe has therefore a vertical movement of approximately 2 in. to 3 in. independent of the frame itself. The weight of the shoe is extremely light compared with the weight of the frame and due to the slight inertia it will readily accommodate itself to irregularities of the wire, whereas the frame could not respond. Not only do these small pantagraphs have a vertical movement, but they also allow the shoe to drag behind slightly in either direction. This design secures quicker movement of the shoe and it thus follows, more nearly, the variations in the wire.

*Westinghouse Electric & Manufacturing Company, New York.

On either end of the middle or wearing section is mounted a horn, which for lightness is made of aluminum. The curvature of the horn is such that when entering from a cross-over, and picking up the other wire, a blow will not result, but the wire will pass smoothly over the horn on to the steel wearing section. A copper shunt at each end by-passes the current around the flexible connections of the shoe. One end is connected to the horn casting, to which the wearing plate is attached, and the other to the frame. A hook at the end of the horn is noticeable. If by chance, due to slight displacement of the wire, or from other causes, the overhead contact wire should slip off the end of the steel wearing section and onto the aluminum horn, the hook would normally prevent it from slipping entirely off and the pantagraph becoming wrecked due to "hooking over" the wire.

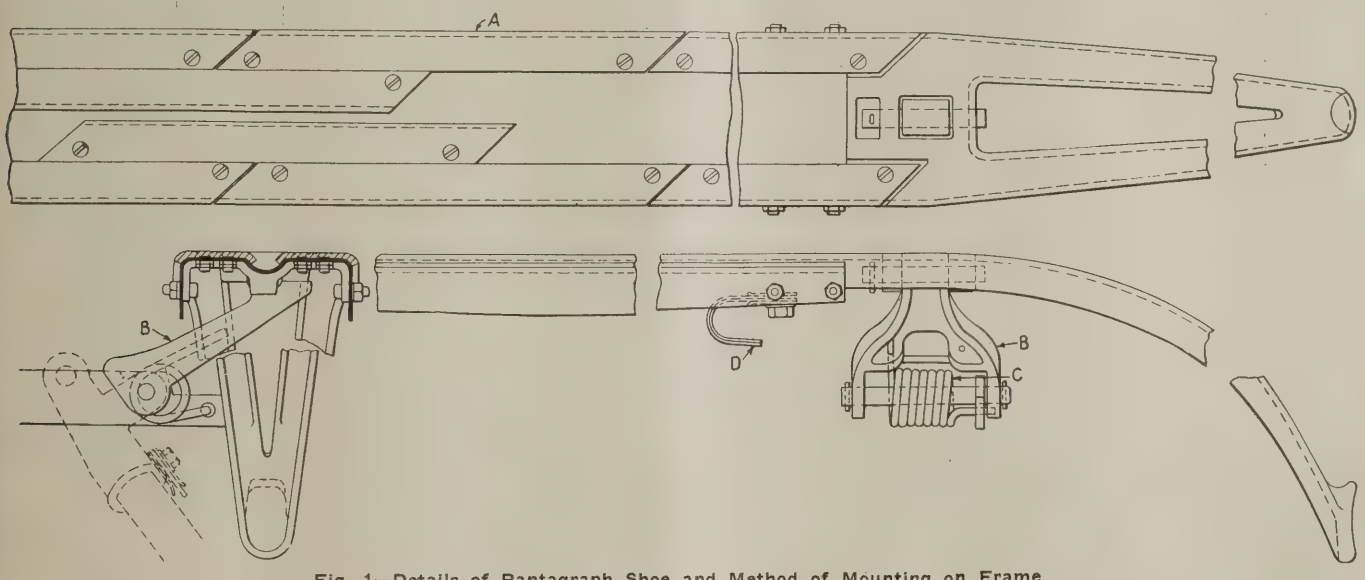


Fig. 1—Details of Pantagraph Shoe and Method of Mounting on Frame

Slow speed operation does not generally require a flexible shoe although it is desirable. As the current exceeds 100 amperes in starting, more metal is required to absorb the heat. To handle starting currents of 250 amperes and running currents of 150 amperes, the shoe must be six inches wide and not less than ⅛ inch thickness of metal. When the starting current exceeds the 250 amperes, it is desirable to place copper strips on the steel shoe, and currents up to 500 amperes can be satisfactorily collected.

We have described rather fully the construction and design of the pantagraph trolley for high voltage single phase operation on locomotives of various speeds and capacity. While the pantagraph was being developed in connection with single phase system, the direct current system had not been used at the high voltage of 2400 volts or 3000 volts, so that for heavy traction, the

direct current was collected from a third rail. During the past 3 to 5 years, however, the high voltage direct current has been developed. This high voltage, account of insulation and creepage distances, could not be handled on a third rail, so that it has been necessary to go to an overhead wire. Immediately it became necessary to consider the pantagraph as the type of collector, for it is, in general, a high speed collector. The problem involved, however, was how to collect from the wire, the amount of current necessary. What form or type of shoe would be satisfactory to collect the high currents required? The first type of shoe was a roller. It consisted of a Shelby steel tube 5 in. in diameter and 24 in. long and of ⅛ in. thickness after being turned both inside and outside. A shoe of this type, fitted with two horns, is extremely heavy for pantagraph trolley construction. The complete roller, including the bearings, weighed approximately 31 lb. compared with 5 lb. for the sliding shoe. It could not be expected to follow the trolley wire and some flexibility was secured by

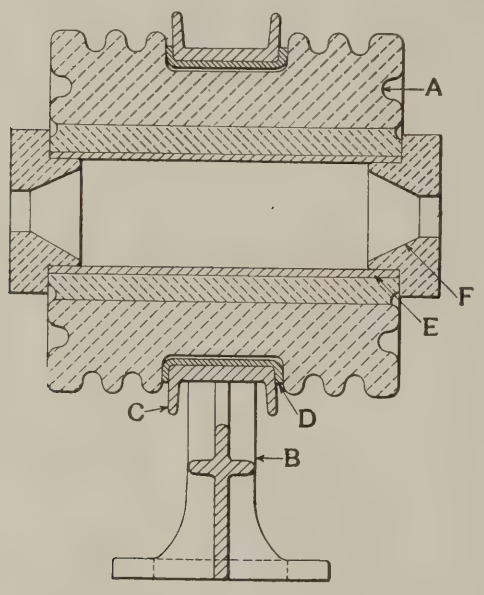


Fig. 2—Type of Insulator Used in Supporting Pantagraph for 3,000-volt Operation

operating with a pressure of approximately 35 to 38 lb. against the wire. This high pressure was sufficient to raise the contact wire to a height at which the weight of the wire became the same as the upward pressure of the pantagraph. The hangers supporting the trolley wire from the messenger cable were of strap steel looped over the messenger, thus giving free upward movement of the trolley or contact wire. The flexibility was thus in the trolley wire rather than in the shoe. While the roller shoe was made to work it was not the ideal arrangement by any means. The ordinary bearings for the roller to revolve in could not be used, for after a short time the roller would become stuck and immediately a groove would be worn in the roller or a flat spot formed rendering the roller unfit for service. While special oil lubricated sleeve bearings gave fairly satisfactory service for freight service at speeds of 15 to 30 miles per hour, there was excessive wear in passenger service at speeds of 45 to 50 miles per hour and special roller bearings were necessary.

The operation of the roller pantagraph was such that study was made as to what could be accomplished with the sliding shoe. Not alone was the pantagraph heavy and costly but the principle did not lend itself to high speed heavy traction. The rapid revolving of the roller at high speeds made it necessary to have the balance perfect.

As mentioned above, currents up to 500 amperes had been collected satisfactorily by a single shoe fitted with

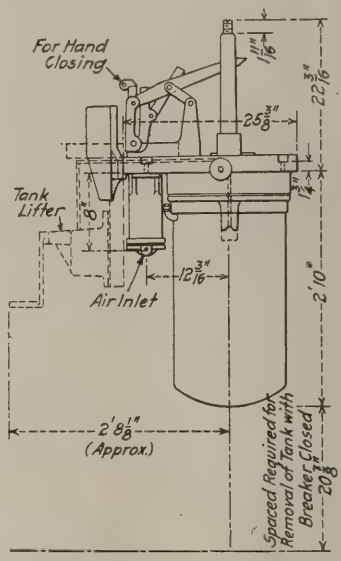


Fig. 3—Oil Circuit Breaker to Which the Current Is Led from the Pantagraph.

copper contacts. To collect the current demanded with 3000 volt D.C. operation, a double shoe has been developed which is capable of collecting 1200 amperes at starting and 600 amperes at 60 to 70 miles an hour.

The pantagraph is the same as the single shoe type except instead of one shoe located centrally, there are

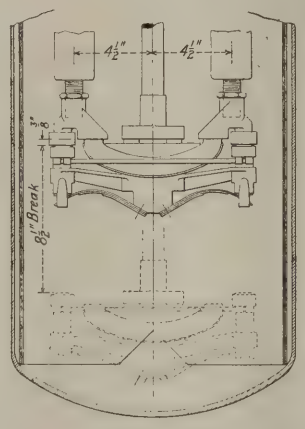


Fig. 4—The Contact Arrangement of the Circuit Breaker Shown in Fig. 3

two similar shoes 6 or 8 inches apart parallel to each other. Each shoe works independently of the other and is flexibly supported. The details of the shoe and the method of mounting on the frame are shown by Fig. 1.

The sliding shoe has screwed to it strips of copper *A*. Near the center these strips are doubled up as the trolley wire is near the center the greater part of the time. The method used in mounting is interesting. To each horn is fitted an arm or lever *B*, which is pinned to the frame. A spring *C* is used to obtain the auxiliary pressure and

to provide flexibility. Each shoe is independent of the other and being flexibly supported follows the trolley wire nicely. Shunts of braided copper *D* carry the current around the joints and springs.

With 3000 volt operation, it is not necessary to fit the pantagraph with the high voltage insulator illustrated on page 116 of the April issue, but a cheaper one can be used. A type as shown by Fig. 2 has been developed.

The porcelain insulator *A* is held to the stand *B* by the clamp *C*. Between the clamp and the porcelain there is placed a lead pad *D*. A wrought iron bushing *E* fits the inner bore and malleable iron bushings *F* are provided for the mounting of the base of the pantagraph on the insulators.

The pantagraphs described above have been of a type which can almost be termed "standard" in this country, in that they are spring raised and air lowered. There are several other methods used which we will just touch on but will not describe fully.

One of the simplest is the "spring-raised hand-lowered." This arrangement would be the most natural in the earliest types as it follows the same principle as the common trolley car. One or two tension springs is sufficient to obtain the pressure and an insulated rope tied or fastened to the under part of the shoe or frame provides the means of pulling the trolley down by hand.

A type, just the opposite of the standard has been used extensively in Europe. Air is used to raise the pantagraph and it is lowered by gravity. Pantagraphs of this type have been used in this country although not extensively. The great disadvantage is, that when there is no air on the locomotive the shoe must be held against the wire until the electric compressor has operated long enough to pump up air pressure sufficient to keep the shoe in contact.

In connection with the standard air lowered pantagraph the full air pressure should not be admitted to the "trolley down" cylinders, as the motion will be too rapid, resulting in breakage of the frame, etc. To prevent the sudden pressure a diaphragm having a hole 1/16 in. in diameter should be inserted at a union in the air connection to the main cylinder. The pantagraph is then brought down slowly. Rubber hose is used for the air connections and these must be of sufficient length so that under conditions of snow and sleet the creepage distance will be ample. Care must be taken so that the rubber hose does not touch the roof, otherwise the creepage distance will be cut down and flashing of the high voltage to ground will occur.

The current collected by the pantagraph is carried into the cab through a high tension cable passing through a pipe. One end of this cable is bolted or held by screws to the frame work of the pantagraph and sufficient length of cable is left outside of the pipe to prevent creepage of the current during rain or sleet. Usually from 3 to 4 feet of cable is left for 11,000 volt service.

The other end of the cable terminates in an oil circuit breaker. The circuit breaker is used to close the high voltage current to the transformer. It corresponds to the main switch of a low voltage circuit but in addition it is automatic, opening on overloads or short circuits in the locomotive.

One of the latest types is shown in Fig. 3. It consists of an operating handle, fitted with a releasing trigger, which is connected to a rod of insulating material carrying contacts. When the handle is pushed down the movable contacts are raised and make contact with stationary contacts, thereby connecting the 11,000 volt high tension to the transformer. The contacts are surrounded by oil carried in a tank. The oil is used to extinguish the high voltage electric arc which is formed as the breaker opens. The arc is nearly negligible when broken in the oil.

Additional to the hand lever there is an air piston which enables the breaker to be remotely controlled by the engineer from either end of the cab. The hand lever is only necessary in first starting up when there is no air available on the locomotive.

The contact arrangement in the circuit breaker tank is shown in Fig. 4. It will be noted that the strips on the movable plunger which carry the greater part of the current after switch is closed, are protected from becoming burnt by the arc when the switch is opened. This is accomplished by two auxiliary contacts under spring tension, which are first to close and last to open in the operation of the switch.

In our next article we will consider the collection of current from the third rail and will discuss various types of third rail shoes.

Sleeping Cars for Japanese Railways.—The Imperial Government Railways of Japan have designed a type of sleeping cars for third-class passengers which, according to the Railway Times of Tokyo, is an ordinary day coach, the seats of which are convertible into lower berths, while the upper berths are attachable at night. On the upper beds, which are located along the direction of the car, passengers can sleep in the usual Japanese manner, and on the lower, which are located crosswise, they can lie on their sides and can stretch their feet. The fare will be about 1 yen (50 cents) per day, including the extra fare for the high-speed train, and it is hoped that fairly good rest may be enjoyed by third-class passengers, which is the most important class in local passenger traffic.

Photograph by International Film Service Company, Inc., N. Y.

Americans Guarding the Ludendorff Bridge Over the Rhine Near Remogen

The Trials and Troubles of a Car Lighting Man

Hinkey Dee Explains to Jimmy Goat Some or the Mysteries of Storage Battery Construction

I DON'T suppose there is any one that knows any more about car lightin' than me and I'm positive there are few who knows as much as me. Now, there's Jimmy Goat, he thinks he's a wonder when it comes to car-lightin', but he's a big bluff, why, honestly he don't know nothin', why just yesterday he gave me the biggest surprise of me life when he said he often wondered how they made storage batteries. Now, wouldn't that jar you! To think that that poor boob has been workin' on car-lightin' longer than me and he didn't even know how they make storage batteries. Well, when he made that remark I laughed and said, "Why, Jimmy Goat, do you mean to tell me that you don't know how they make storage batteries?" "No, I don't, Hinkey Dee," he said, "do you?" I smiled to meself and said, "Yes, Jimmy, I don't only know how they make them but I know the man that made the first one. I was there when he made it. Yes, indeed, Jimmy, I was there when Robert Fulton made the first storage battery." Jimmy Goat was sure surprised and said that he remembered he studied all about Robert Fulton when he went to college but that it had slipped his memory. Finally, I said, "Well, if you really don't know I'll tell you, Jimmy." Just then the boss come along and stopped to hear what was going on. I said to meself, "Hinkey Dee, now's your chance to show the boss how much more you know about car-lightin' than Jimmy Goat." I said, "Jimmy Goat, you fellers don't really have an idea of how good my brain is on car-lightin'. Why I've just been thinkin' about startin' a factory a makin' the very thing your wantin' to know about, and don't be surprised if some day when your walkin' down Wall Street to look up and see a big building with a sign on it, 'The Hinkey Dee Storage Battery Factory.' You know Jimmy in order to start a factory a-makin' storage batteries you have to make a study of them and know all about them and I don't mind lettin' you in on the scheme bein' you don't know how they make them.

"Well, Jimmy, in makin' a good, first-class, up-to-date storage battery, you must first pick out a good grade of wood, to make the boxes. The wood musn't be too hard nor too soft, but just medium on account of the resistance, and you musn't pick out a wood with too much iron or copper in it, Jimmy. Mahogany wood is considered the best wood for making storage battery boxes cause it contains more animal fat, you know, Jimmy, that's where they get lard from pigs and mahogany wood that's why they put the hog in the word mahogany.

"Now, Jimmy, after you have picked out a suitable wood for makin' the boxes then you have to line the boxes inside with sheet lead. Yes, sheet lead, Jimmy, you see they line the boxes with sheet lead so's to screen out the magnetism. It keeps it in also. You'd hardly believe it, Jimmy, but I know it's right, because I read it in a book and I also made up a set of batteries one time without any lead linings and they wouldn't work at all. So you see, Jimmy, I know from both work and books that the wooden boxes have to be lined with sheet lead on account of the magnetic lines of force. Next you put black sheets against the lead linings so's to keep the light from striking the lead linings. You know, Jimmy, that the reason the light musn't strike the lead linin' is because if the light would strike the lead linin' it would spoil it, just like

The boss just looked at me kind of half sick but he didn't say nothin'.

the light spoils the film in a camera. Do you understand, Jimmy?"

Jimmy said, "Yes, Hinkey, since you started, everything I learned at college is comin' back to me." The boss just looked at me kind of half sick, but didn't say nothin'.

Then I started again, I said, "Well, Jimmy, I forgot to tell you that before you put the lead lining in the wooden boxes you have to put hot stuff like black molasses in the boxes so's to glue the lead linings to the wooden box. You see, Jimmy, if you didn't have the lead linings stuck in they'd work loose and get hot." Jimmy said he understood exactly what I meant. Then I said, "Jimmy, your next part is the insides or the lead sheets. You see these sheets are stored inside the boxes, that's the reason they call them storage

batteries. Just like cold storage, dead storage, or live storage, or any other kind of storage, you see, Jimmy, it's all storage. Now these sheets, or plates, as some people call 'em, but sheets is the right name, is made from lead just like lead pipe or lead pencils and all but you have to be careful to have the right colors. You see there are two kinds of colors, the positive and those that are not positive. You know, Jimmy, care must be exerted when these plates are made, to have them the right color. Anybody that knows all about car-lightin' will tell you that the color of the plates is the most important part of the battery. Why, Jimmy, it's just like a person. If a person is sick they haven't the right color, they're pale and swallow lookin'. You'll often see a person with a bad color who doesn't think he's sick but he is, Jimmy, Yes! That's the way with a storage battery, it gets just as sick as a person does when its not the right color. Now the positive sheets should be brown just like roast beef and those that are not positive should not be brown like roast beef, but should be gray like snow. Now I suppose because I told you that they were different colors you think that they are different. Naturally everybody thinks that, that is anybody that don't know all about car lightin' like me. But Jimmy they are alike, the only difference is that one is raw and the other is cooked. You see when you're makin' storage batteries you take half of the sheets and cook them. Yes, they're put in an oven and roasted until they're brown. That brings out the point I was telling you about a minute ago about the color. If you forget it any time, Jimmy, just remember the positive sheets are roasted and the ones that are not positive are raw, just like bread before its baked.

Now then I guess you have noticed them white things in the bottom of the cells, you know, Jimmy, the porcelain rests some people call 'em. Well them's put in there just because the sheets or plates are not long enough. You see if them things weren't there the sheets wouldn't be long enough to stick out the top the way they do. They make them out of porcelain so they'll stay in the bottom, if they were made out of iron or lead you see they'd float on top and wouldn't stay in the bottom. They are really nothin' more than blocks, Jimmy. Yes, blocks to block up the sheets.

"I forgot to tell you about the sheets bein' fastened together with a lead bar. Some fellers that don't know much about car lightin' and don't know how to talk like an electrician like me, call them bridges. Now I guess you wonder what they're for. Well, I'll tell you, thems across the top of the sheets so's to stop anything like a hammer, or a screwdriver, or a pair of plyers from falling down between the plates. They're mighty handy to, Jimmy, for example when you're working on a battery you can lay your tools on them and they don't get lost.

"I guess you have noticed those pointy things sticking up on the lead bars, well thems put on there to hold the bars or bridges in place. You see if them things weren't sticking up, the bars would move every time the car started and stopped. What's that, Jimmy? You want to know what's that stuff is you pour into the battery? Why, Jimmy, thats just stuff mixed with water and is used just so as to preserve the plates and keep 'em cool. Just the same as you see them put water in the radiator of an automobile or see the folks at home preserve apples and peaches and all; they put them in jars and pour stuff over 'em just like in a storage battery.

"Now, Jimmy, I told you all about the boxes, lead insides, black sheets, porcelain things in the bottom and the plates and bars. I forgot to tell you that they put the black sheets between the plates but that isn't so very important anyway. No, Jimmy, you see they just put these black sheets in between so's to give the thing a finished look. It makes the plates stand out and look nice, just like when you have your picture taken they put a black sheet in back of you.

"When you have all these things put together all's you have to do is put tops on the boxes. They'll work all right without the tops, but if the tops wasn't on some feller might sit on the boxes and get all damp. The covers also keep the light out of the battery and that makes 'em last longer too. After you put the covers on, you tie the boxes all together by fastening wires to the posts on all the boxes. You see if you didn't have something to hold 'em together they'd get moving around and get lost.

"Now, Jimmy, there's one thing I didn't tell you about and that's very important, and that's about the tops. Always put a hole in the top. Yes, you have to give the battery a chance to breathe, just like people. If you didn't have a hole in the top the battery couldn't get any wind and would smother to death. Then you'd have a dead cell."

The boss took a good look at me and walked away. It sure did make me feel good to know that I had showed the boss right before Jimmy Goat that I knowed a whole lot more about storage batteries than Jimmy did.

Jimmy said, "Hinkey Dee, I've worked on storage batteries for twelve years, but I never have met any one who could describe and explain how to make a storage battery like you can." Jimmy said "I have read and studied a number of books on storage batteries, but none could explain them as clearly and as forcefully as you did." I told him that everyone knew I was good at car-lightin' and that I had a big head on me shoulders. I said, "You know, Jimmy, there's a lot about car lightin' that comes from books and there's a lot you get from workin' at car-lightin', but then there's a third part, you have to use your brains to know and that's what makes me so good. You see I have read all the books on car-lightin', I have worked on car-lightin' and I have a good level brain. That's why they call me Hinkey Dee, the Electrical Expert."

SWEEPINGS FROM SHOPS.—Attention has often been called to the importance of combing the sweepings which are hauled from the various shops, roundhouses, storehouses, etc., to the refuse car and taken out along the line and dumped. Yet there is reason to believe that there is much waste bound to accrue from lax methods in caring for the sweepings and an occasional inspection and renewal of instructions is worth while.—*Railway Storekeeper.*

TREATMENT OF STORAGE BATTERY "HOSPITAL" CASES*

By H. M. Beck
Engineer, Electric Storage Battery Company,
Chicago, Ill.

The operation of a storage battery under normal conditions is a very simple matter. However, where a battery has been subjected to abuse, so that it is in an abnormal or unhealthy condition, it becomes what may be called a "hospital" case, and requires special treatment; unless it receives such treatment it will not give satisfactory results in service.

From a practical standpoint this special treatment is not difficult to understand and is hardly more complicated than the normal operation, but due to a lack of appreciation as to its importance it is frequently neglected. This neglect is the explanation of a great deal of trouble, especially in signal service where the discharges are likely to be at low rates and to extend over considerable periods of time.

The terms *capacity* and *efficiency* are often used interchangeably in connection with storage batteries, whereas they do not mean the same thing. As they have a bearing upon the present subject it will probably be better to explain the distinction before proceeding further. The *capacity* of a storage battery refers simply to the ampere hours which it will give on discharge, and has no connection with the amount of charge required to restore its capacity. On the other hand, the *efficiency* of a storage battery is the ratio of the amount of discharge to the amount of charge required to fully charge the cell again, and therefore any losses inside the cell are taken into account. The bearing of all this on the present case is that it is entirely possible to treat a battery so that when it is immediately discharged it will show good capacity, but due to the treatment being incomplete the internal losses may still be high and, therefore, the efficiency low. Unless a battery is charged so that it will show efficiency as well as capacity it will not give satisfactory service. This is especially true in connection with portable signal cells where the discharges extend over a month or two, and the internal losses may become a very appreciable percentage of the capacity rating.

Thus it is important that a battery be charged not only until it will show capacity, but also until it will show efficiency. Under normal conditions the regular charges take care of this and no special problem is involved, but where the cells have been subjected to abuse special care must be taken to see that the plates are restored to efficiency as well as capacity.

Consider a common case, viz., where a battery has been over-discharged, or run down flat due to a short circuit. This does not necessarily mean that any serious injury results provided the proper treatment is given, but without proper treatment the cells are likely to fall down again and eventually be ruined.

Naturally the first requirement is that if the trouble is due to a mechanical defect, such as a short circuit, this shall be corrected; and the final requirement is simply charge and plenty of it. In a large majority of cases failure occurs because the charge is considered complete when the cells are in shape to show capacity, but the active material has not yet been worked back into proper mechanical condition and the cells would therefore not show efficiency.

Where a battery is discharged beyond the point for which it is designed, it becomes inefficient and a surprising amount of charge is required to restore it. In bad cases the best method to follow is to dump out the electrolyte, fill the cell with water and charge the plates in water. Actually this is not water, as there is always a slight amount of acid left in the cells or separators. Charging in water seems to restore the plates somewhat more quickly and bring them into better final condition. If the specific gravity rises during charge to anything like normal before it is completed, the electrolyte should be dumped a second time and the cell again filled with water.

The charge must be continued not only until the voltage and gravity reach a maximum, but until the active material of the negative plates is restored to normal condition, and this frequently necessitates charging considerably beyond the point where the voltage and gravity apparently cease rising. Passing upon the condition of the active material requires considerable experience, and the best standard which can be given is the condition of a new negative plate at the end of the initial charge. In other words, the charge should be continued until either the plates come back to this condition, or it is evident that further charging is not resulting in any improvement.

Where the plates are in good shape mechanically the above treatment can nearly always be counted upon to restore them to capacity and efficiency; and if these results are not obtained it is nearly always because the charge has not been continued long enough.

When there is time and it is desired to check the condition of the cells which have been treated, the best and possibly only satisfactory test is a standing test. The battery at the end of treatment should have the electrolyte adjusted, be given a freshening charge and then immediately discharged at the normal rate. Its capacity is thus established. It should then be recharged and allowed to stand on open circuit for a couple of weeks, when it should then be discharged without any preliminary charge. The capacity obtained when compared with the original capacity will show whether there is any serious loss occurring due to internal discharge taking place while the battery is standing; if this occurs the battery was not sufficiently charged in the first place. On the other hand, if no appreciable loss is found this will constitute the best possible evidence that the battery has been properly restored and is in condition to give good service. With a little experience the mechanical condition of the plates is a sufficient check on their state, but where this experience is not available the standing test will be found of great assistance.

*Remarks made on this subject before the Texas regional committee of the Railway Signal Association, at Houston, Texas.

Handbills in Six Different Languages Telling of the 18 night schools for those who wish to learn English, have been printed and circulated at Bridgeport, Conn., by the local committee. The number of non-English speaking persons reported to be enrolled in the night schools of that city is approximately 350 and the handbills give direct arguments as to why this number should be increased.

A New Way of Loading Ocean Freighters

Electrically Operated Gantry Cranes Quickly Transfer Locomotives From Cars to Ship

THE successful loading of locomotives into the hold of an ocean liner without the use of lighters, which is now being accomplished, marks a significant and important step in the development of New York harbor, as it is only recently that the direct loading from pier to ship of freight of the character described has been attempted here. The work is done with the standard pier equipment and no special preparations are necessary for its accomplishment. It has never been attempted because of the well founded impression that damage to fixed

Freight Steamer Being Loaded With Locomotives By Means of Electrically Operated Gantry Cranes

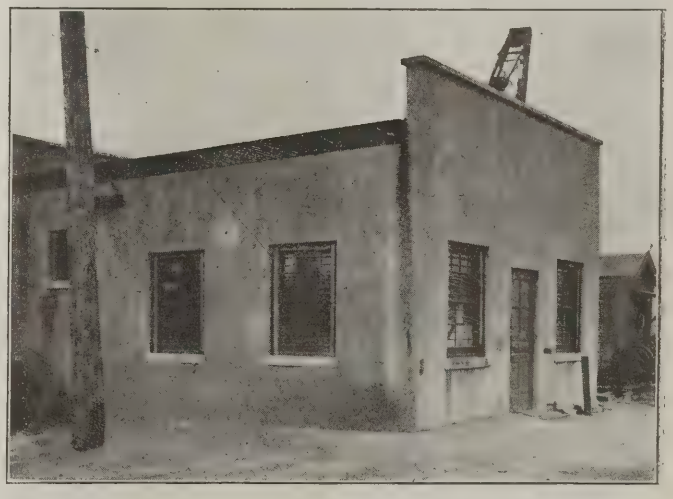
equipment would result. This impression is based on the fact that in many ships the hatches do not have sufficient area to permit free passage to packages of large dimensions, with the result that forcing methods in loading have had to be resorted to. That is to say, large packages often become wedged in the hatchway and when pried loose would drop and shift quickly, setting up strains sufficient to break rigid equipment. When such freight is loaded from lighters and forcing methods are resorted to, the strains are greatly reduced because of the free movement of the lighter in the water.

The freighter Feltore, the first to be loaded with such cargo in this way, is of the single deck type with hinged hatches extending across the ship for almost its full width. For this reason this ship is particularly adapted for such methods of loading. Fifty locomotives and several thousand tons of pig iron were loaded in one week direct from Erie Railroad pier H at Weehawken, N. J., and by eliminating the use of barges, tugs and lighters, commonly required for work of this character, the expense of loading was materially decreased. Most important of all, however, was the saving of time.

Following usual methods, the ship would have been anchored off shore and the cargo moved from the pier by cranes and loaded on to barges. Then from the barges the cargo would have been transferred to the hold of the vessel by the usual lighterage methods. As no more time is required to load the ships direct from the piers than to place the cargo on to barges, the economy of the direct loading is apparent. When it is considered that approximately 50 per cent more time is required to transfer the cargo from the barges by the floating equipment than to load the barges by the pier equipment the importance of the new departure as an economic measure is still more evident, to say nothing of the benefits and savings accruing from the release of the floating equipment, thus making it available for other service.

The 50 locomotives were delivered unassembled to the pier in 200 cars. The car loads were made up of 20-ton locomotive boilers, 14-ton tender tanks, 12-ton locomotive frames, 4-ton cabs, 4-ton drivers and 3-ton cylinders.

During the first day 19 of the 20-ton boilers were loaded in seven hours, a cycle being completed in about 22 minutes. After the seven hours the loading of boilers had to be discontinued while smaller cargo, chiefly pig iron, was placed to prevent shifting of the larger units. The pig iron was loaded with ship's crane and did not



The Small Substation at the Foot of the Pier Where Power Is Transformed From Alternating Current at 2,300 Volts to Direct Current at 240 Volts.

interfere with the operation of the pier equipment, then engaged in loading tender tanks and other locomotive parts.

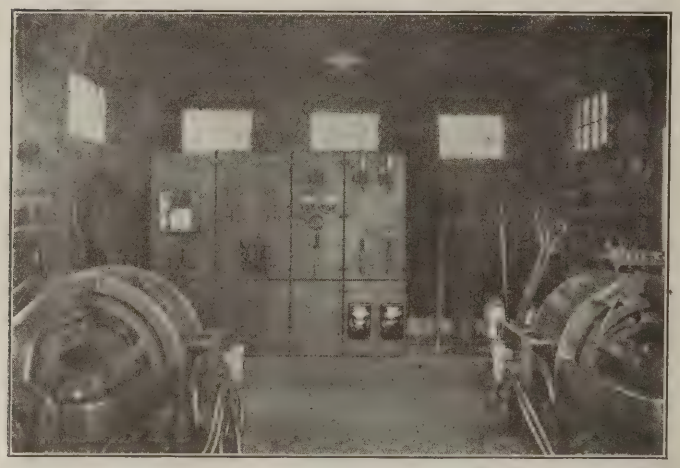
As the cargo could not be loaded on to barges in less time than is required to load it into the ship the initial saving by the new method is fifty per cent. The time which would be required to transfer the load from barges to the ship would depend on the location of the ship in reference to the pier and cannot be arrived at definitely. As a comparison, however, it may be said that the estimated time for transferring a 20-ton locomotive boiler from a barge to a ship is about one hour as compared with the 22 minutes mentioned above. In other words, the time required to load from the pier to the ship is

more than 50 per cent less than that required to load from the barge.

Pier H is of the open-type with timber construction. It is 80 ft. wide and 1,000 ft. long, providing space for five railroad tracks, which extend the full length of the pier, and have a combined capacity for 200 cars, and for two gantry tracks. The center line of railroad track No. 3 coincides with the center line of the pier. The two tracks on the south side of the pier and the two on the north side are spaced on 12 ft. centers. The distance from the center line of track No. 3 to the center line of adjoining tracks is 16 ft., and the distance from the centers of outside tracks to the edges of the pier is 12 ft. The gage of the gantry track is 28 ft., with the outside rail of each track 4 ft. from the edge of the pier.

The pier equipment comprises four electric traveling portal gantry cranes consisting of one 20-ton and one 10-ton crane operating on the south side of the pier, and two 10-ton cranes operating on the north side. The vertical clearance between the top of the gantry rails and the boom in its lowest position is 55 ft., an ample distance to clear the side of any vessel.

All of the cranes have a vertical or hook lift of 90 ft.,



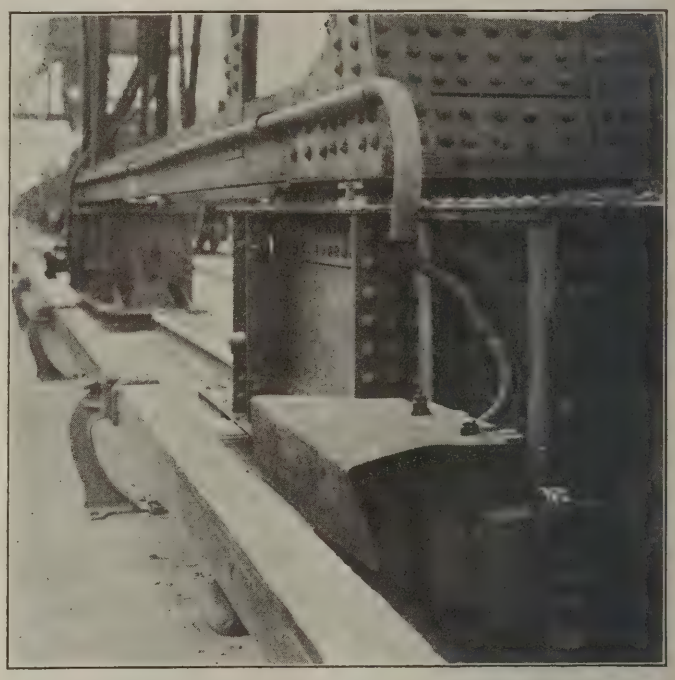
Interior of Substation Showing the Four Panel Switchboard and two Rotary Converters, One of Which is Not in Use at Present

ranging from 30 ft. below the level of the crane rails to 60 ft. above. They all have a rotating movement giving them a working radius of 48 ft. 6 in., permitting each crane to load or unload cars on any track and to reach 30 ft. 6 in. beyond the edges of the pier.

Three of the cranes have a maximum capacity of 10 net tons. These have a hoisting speed for loads up to five tons of 220 ft. per min., and for loads above five tons to ten tons of 110 ft. per min. The rotating speed is three revolutions per min. and the traversing speed is 150 ft. per min. The capacity of the main hoist of the fourth crane is 20 net tons and that of the auxiliary hoist 5 net tons. For loads up to 5 tons the hoisting speed is 220 ft. per min., and from 5-ton loads to 20 tons the speed is 55 ft. per min. This crane has a rotating speed of two revolutions per min. and a traversing speed of 100 ft. per min. All of the cranes have a longitudinal movement for the entire length of the pier.

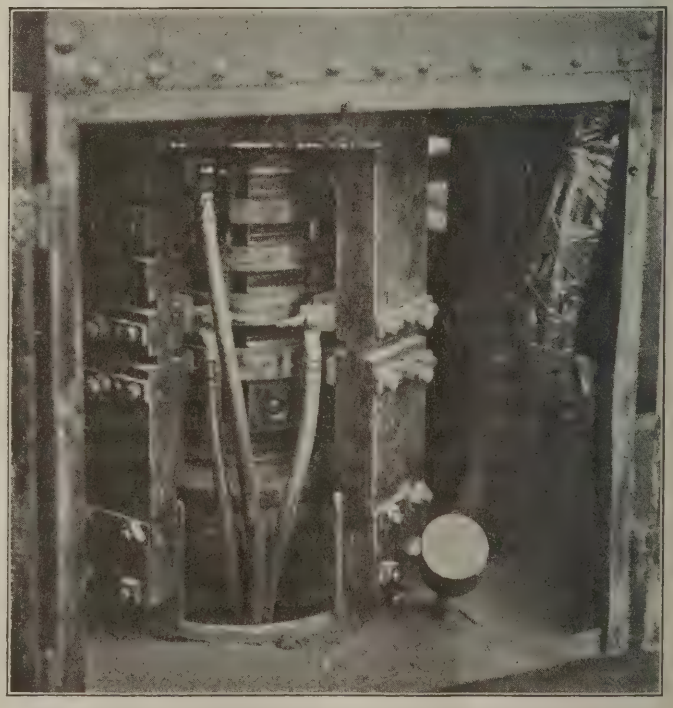
Electrical Equipment

The power used in operating the motors on the four gantry cranes is taken from the line of a commercial power company. Two-phase, 4-wire circuits are run through underground conduit from the pole located about 100 yd. from the sub-station. The voltage of the supply line is 2,300. At the sub-station this current is transformed to a 6-phase arrangement having 163 volts



Third Rail and Shoe for Collecting Current to Operate Motors on Crane

on each phase. This 6-phase alternating current is supplied to a rotary converter where it is changed to 240-volt direct current power for use on the crane motors. There are two of the rotary converters in the sub-station,

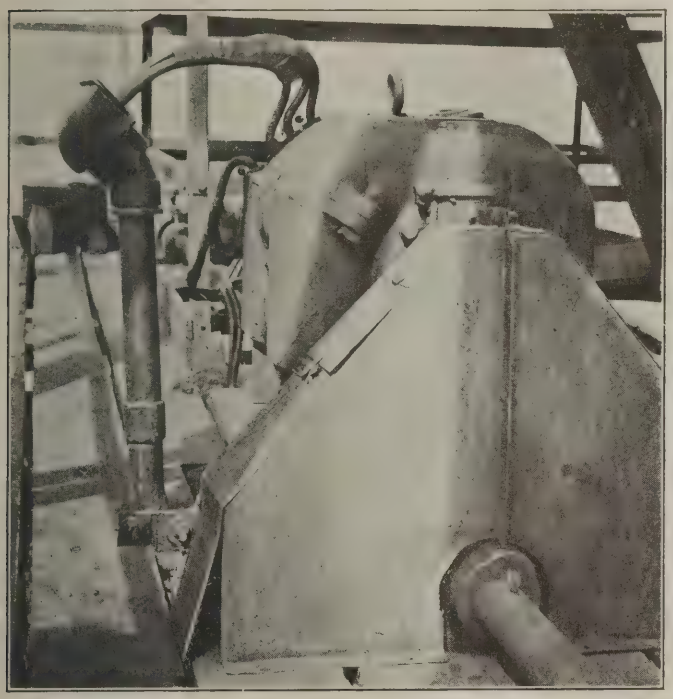


Contact Rings Are Necessary To Maintain the Power Supply When the Crane is Rotated

but at the present time only one of them is in use. The type used is the General Electric HCC 6-pole 200-kw. machine running at 1,200 r. p. m.

The maximum rated current capacity of the rotary converter is 800 amperes. Secondary loads put upon it by the crane motors frequently go as high as 1,600 amperes, but the converter takes care of these without difficulty.

The direct current at 240 volts is supplied to the third rail by means of which power is carried to the crane motors. The type of third rail used in this installation is somewhat similar to that used on the electrified section of the New York Central, being covered on the top and two sides with wood. This not only acts as a protection to workmen on the pier, but also makes less liable



A 25-hp. Fully Enclosed Motor for Traversing the Machine. The Power is Transmitted by a Shaft Through Bevel Gears to the Wheels

any short circuits due to chains or cables being dropped upon the rail.

There are four panels in the sub-station switchboard. Upon panel No. 1 is mounted the oil switch to close the 2,300-volt line, a graphic wattmeter and the main meter. Panel No. 2 contains the starting and running switches. Panel No. 3 is the main distributing board and has on it the main breaker, the main switch, ammeter and voltmeter, field rheostat and voltmeter plug. Panel No. 4 is a branch board with two breakers and two switches, each feeding separate third rails on the side of the pier. This panel also contains wattmeters which record power used on each side of the pier. The current is led from the sub-station switchboard to the third rail in underground 2½-in. pipe, 1,000,000 circular mil cable being used for this purpose.

Each crane is equipped with three electric motors, one each for traversing the crane, rotating the jib, raising and lowering the load and raising and lowering the jib. These motors are all 230-volt series wound direct current machines, and each one is protected by overload relays mounted on a panel in the crane cab.

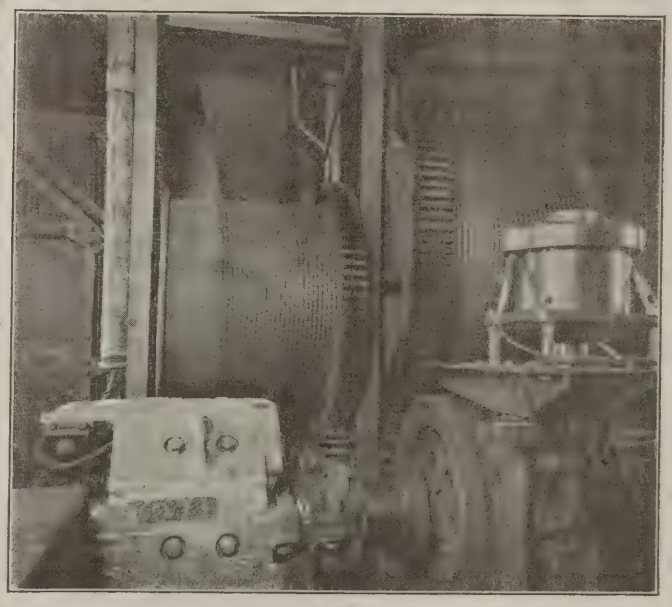
The cranes are mounted on equalizing structural steel trucks, one 2-wheel truck being provided for each of the four corners of the portal. The truck connection to the portal structure is flexible, thus equalizing the load on both wheels at each corner.

A 25-hp. fully enclosed motor located on the portal and connected through cut steel gears to one wheel at each portal provides an equal tractive effort for traversing the machine irrespective of the direction of the wind. The motor is equipped with a drum type controller located in the cab. Whenever the power circuit is opened, by accident or by the operator, a magnetic brake provided on the armature shaft of the motor automatically stops the traveler.

The operator's cab is so located on the crane that the operator may have a plain view of the operations at all times. The cab is heated electrically.

The hoist motor consists of an 81-hp. open mill type motor connected through cut steel gearing to a cast iron drum hoist. A magnetic brake on the armature shaft of the motor automatically acts to hold the load whenever the power circuit is open. In addition, an H. & P. standard brake and friction clutch is provided in the drive to disconnect the hoisting drum and hold it stationary while raising or lowering the jib. The combined brake and clutch is so constructed that the brake will be normally set and the clutch released. The clutch is set and the brake released by means of a solenoid.

The controller for the hoisting engine is of the magnetic contactor type and gives either power or dynamic braking, whichever may be necessary for lowering the empty hook without any shift of the controller handle.



Interior of the Crane House Showing the 81-hp. Motor and Drums for Hoisting

Limit switches automatically prevent overhoist of the load.

The crane jib is hinged and is raised or lowered by a heavy forged steel screw running in bronze nuts connected to the top chord of the jib through steel links. Limit switches limit the travel of the boom in each direction.

The rotary movement is effected by a 33-hp. crane type motor connected through steel gearing to a heavy steel gearing bolted to the top of the portal. The motor is equipped with a drum type controller located in the cab

and a magnetic brake on the armature shaft of the motor automatically stops rotation whenever the power circuit is opened.

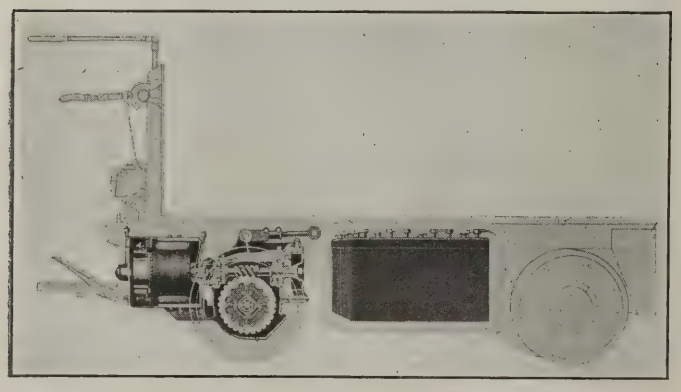
The control equipment for operating the crane consists of drum controllers for the travel, and the rotating motors and a master controller for the hoist motor. The latter is provided with an auxiliary interlock having three positions, (1) providing for the operating of the hoist engine; (2) for operating the hook; and (3) for lowering the boom.

The cranes and electrical equipment on the pier were furnished by Heyl and Patterson, Inc., of Pittsburgh, Pa.

INDUSTRIAL TRUCKS WITH STANDARDIZED PARTS

Standardization of parts whereby the essential details of various styles of industrial tractors and utility trucks are made interchangeable is a noteworthy feature of the equipment manufactured by the Baker R. & L. Company, Cleveland, Ohio. Some of the salient features of this system, under which 98 per cent of all vital parts are said to be identical, will be found of interest to those concerned with the installation and operation of industrial trucks for handling freight and baggage or supplies at shops and storehouses since the interchanging of parts from one machine to another greatly reduces the necessary supply of spare parts.

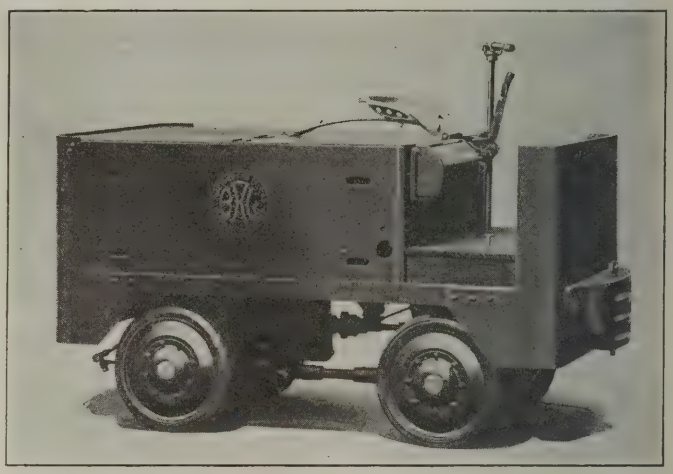
An adequate comprehension of the system necessitates a general knowledge of the make-up of these trucks of both the tractor and burden-carrying models. All of the standard trucks are of the four wheel steering type, that is with all four wheels swiveled by the action of the steering lever, the arrangement being such that all wheels travel on arcs having a common center. Under this arrangement the load is applied from a structural steel



Phantom View of a Utility Truck Showing Details of the Power Unit

platform through a spring pedestal to the top of the knuckle. The standardization idea is carried throughout this detail since the same steering knuckles, jaw parts, wheels and tires are used on the trailing and power axles of both the tractors and utility trucks. The tractors are either two-wheel or four-wheel drive but the trailing axle is substantially the same as the power axle with its differential and driving parts omitted. The application of power and transmission is the same in all types, except that a 48-volt motor is used for the tractor instead of the 24-volt type used for the general utility truck. However, the worm drive, as shown in one of the photographs, with a single reduction direct to the driving axle is standard throughout all of the types. By extending the motor shaft to the other pair of wheels and replacing the trailer shaft by another drive shaft, the truck is readily transformed from two-wheel to four-wheel drive.

The working conditions and purchaser's requirements determine the battery equipment. With a view to having battery trays for tractors and trucks made up of identical units the standard truck battery compartments provide for two trays of 6 lead cells or two trays of 11 to 12 Edison cells. In the case of the high platform utility



A Tractor of the Four-Wheel Drive, Four-Wheel Steer Type

trucks the battery compartment is underneath the platform between the wheels, whereas in the tractor and the elevating and low platform trucks, the battery compartment is on top of the platform.

Standardization of parts is also applied to the auxiliary equipment. The controller, which is of the continuous short-drum type in a cast metal housing, is the same on all the models. This is also true of the automatic switch operated by a foot lever so that the current is on only when the operator has his foot on the lever. This standardization between models has been made possible by the simultaneous development of all the basic units. It contributes materially in shortening the time that the trucks stand in the repair shop.

IF YOU THINK—

If you think you are beaten, you are;
If you think you dare not, you don't.
If you'd like to win, but think you can't,
It's almost a cinch you won't.
If you think you'll lose, you're lost,
For out of the world we find
Success begins with a fellow's will—
It's all in the state of mind.
If you think you're outclassed, you are,
You've got to think high to rise;
You've got to be sure of yourself before
You can ever win a prize.
Life's battles don't always go
To the stronger or faster man;
But soon or late the man who wins,
Is the man who thinks he can.

A Few Points in the History of Car Lighting

How the Illumination of Passenger Coaches Has Been Developed from a Crude Beginning

By Chas. W. T. Stuart

RAILROADING had its beginning about 1620 with a wooden track road built at Newcastle-on-Tyne, England, for the purpose of hauling coal wagons with horses. Various other roads were built for the purpose of hauling merchandise by horses, but it was not until 1825 that the first passenger carrying vehicle for railroad work was built. In that year a coach called "Experiment" was built by the Liverpool and Manchester Railroad. This car was drawn by a single horse and had seats along the side to accommodate six or eight passengers. A door and steps at the rear was the only means of entrance. It was leased to a Thomas Dixon, who operated it for several years between Stockton and Darlington. The advent of the "Experiment" marked the beginning of car lighting; Thomas Dixon furnishing a candle for illumination purposes on dark nights, the passengers being required to tend to it themselves. Later he furnished a table in the center of the car to hold the candle. As the number of passenger cars increased lighting methods improved, the first improvement being sockets placed on the sides of the car to hold the candles. Later chimneys were supplied to protect the flame. Then a coiled spring was used in the bottom of the holder to force the candle up as it burned away, maintaining the flame at a pre-determined position. This type of candle lamp is still in use as an auxiliary light in case of failure of the primary gas or electric system. The use of candles continued until the introduction of oil about 1850.

The first oil lamps were a development of the improved candle lamps and gradually developed into the modern center draft burners, which are still in use in certain parts of this country at the present time. Oil was superseded as an illuminant about 1875, at which time gas lighting was generally adopted. Coal gas was probably the first used, other kinds being used later. Gasoline mixed with air was very extensively used, as was also acetylene gas. Pintsch gas, invented in 1867, soon came into very general use on account of its reliability and increased storage capacity, obtained by compression. The first gas lamps were of the flat flame or fish tail burner type. The mantle lamp was at first unsatisfactory, but a suitable material was soon found, and this type of lamp was used extensively for car lighting purposes. At the present time both flat flame and mantle lamps are still in use.

The first attempts at car lighting by electricity were made in 1881 and continued in an experimental stage for ten or fifteen years, during which time it reached a real and serviceable state. Three general methods have been developed, all of which are in use to-day. These three methods are: (1) Storage battery system, in which the current is supplied exclusively by storage batteries, either as individual units on each car or one battery for lighting several cars. (2) Head end system, in which current for entire train is obtained by use of engine generating set. (3) Axle generator system which provides lighting for each car as an individual unit. The first method is the simplest but is not flexible enough for general service. The first practical storage battery was developed in 1860, by Planté, in France, and the pasted plate was a later development, being brought out by Faure in 1878. The Planté type of battery was the first to successfully meet car lighting requirements.

In 1881 the London, Brighton & South Coast Railroad of England tried lighting some of their cars by means of a storage battery. Their experiment was not very successful and they soon developed a head end system for the purpose, although continuing the use of storage batteries alone. In 1886 a French road operated a train equipped with a set of bichromate primary batteries for about a year, between Paris and Brussels. This experiment was also very unsatisfactory, due to imperfect and expensive batteries, but with later developments of the battery this type of equipment came into general use in France and other parts of Europe. In 1887 the Jura and Simplon Railroad in Switzerland began to install electric lighting by means of batteries and gradually introduced this system to all their cars. In Germany the storage battery was very generally used and by 1893, twenty-five hundred mail cars alone were lighted by this method.

The use of storage batteries in this country had its beginning about the same time as in Europe. In 1886 the Boston & Albany Railroad equipped a few cars with batteries but found it a rather costly experiment. In 1885 the Pennsylvania Railroad equipped eight parlor cars with batteries. This method was extended considerably by the Pennsylvania and a majority of their cars today are lighted only with storage batteries.

The next development in car lighting was the so-called head end system, where the entire train was lighted by means of a generator in the front end. This was accomplished by several methods: (1) Generator in baggage car driven by belt to car axle. (2) Generator on locomotive driven by steam turbine. (3) Generator in baggage car driven by steam turbine or gas engine. In 1883 the London, Brighton & South Coast Railroad, England, mounted a generator in the guard's van and belted it to the axle, using a storage battery auxiliary for light when the train stopped. A mechanical device served both as pole changer and automatic switch, the batteries being depended upon as a regulator. In 1884 the London & Northwestern Railroad employed a steam driven dynamo on the back of

the tender for lighting the entire train. No storage battery auxiliary was used. In 1887 the Pennsylvania equipped their Florida special trains with steam driven generators in the baggage car. These original machines continued in operation until about 1902. In 1888 the Chicago, Milwaukee & St. Paul Railroad equipped a special car with a boiler and engine generator set to heat and light the entire train during the winter months. During the summer months this engine and dynamo were transferred to the baggage car for lighting purposes. The Baltimore & Ohio Railroad also equipped several trains with this system about this time. The use of gas driven engines and dynamos is confined chiefly to certain Russian and Chinese railroads. In 1904 the Pennsylvania first used a steam driven generator mounted on the engine for lighting trains, using batteries as an auxiliary. This system was later improved by the addition of the Gould booster, designed to boost the charging voltage to the batteries independent of the lamp circuit.

The third system of car lighting with axle driven generators was developed about the same time as the head end system, but was very unsatisfactory at first. It has been so much improved during recent years, however, that it has practically supplanted the turbo-generator equipment and is gradually pushing the straight storage system out of the field. The first axle driven generator was of the head end type but later individual units were applied to each car.

The axle generator system consists of a generator driven from the car axle, with a set of batteries and necessary regulating apparatus. A remarkable number of these equipments were developed both in Europe and this country. About the first equipment which we have any record of was one used on the Central Railroad of New Jersey in 1894. This was rather crude, but notwithstanding the large amount of mechanism involved, gave some satisfaction. About the first equipment in practical use was the Stone. This was invented in 1894 by A. B. Gill and improved and developed by J. Stone & Co., of Deptford, England, in 1896. This uses a slipping belt for regulation and is the only one of its kind. Among the very numerous systems which were developed in Europe some of the best known and most used were as follows:

The Vicarino and Dick equipments, perfected in 1900 and used principally in Austria and Turkey.

The Brown-Boveri equipment, used in England, but largely in Switzerland, perfected in 1902.

The Rosenberg equipment, using a generator having the property of supplying current in the same direction, irrespective of the direction of rotation. This is used generally on the Prussian State railroads.

The Pintsch-Grob equipment used on Prussian and Saxon railroads, also on Austrian, Danish, Russian and Swiss railroads. It was tried out in this country but could not meet the requirements of American roads.

The Buttner equipment with Rosenberg generator, used exclusively in Germany.

The Electric Car Lighting Company's "GEZ" equipment with Rosenberg generator, used principally in Germany.

The Leitner equipment used in England.

The Mather Platt equipment used in England.

Among the American equipments the earliest one was developed by Morris Moskowitz in 1895 and later improved by the U. S. L. & H. Co., which company also developed the Bliss equipments.

Another early equipment was the one of the American Railway Electric Light Company's. This was first put into service on a Pennsylvania car in 1896 and was apparently the first equipment to employ the principles of field rheostat control of generator voltage, a principle which forms the basis of many later equipments.

The McElroy equipment, about 1905, was developed by the Consolidated Car Heating Company.

The Safety, Gould & Newbold appeared between 1900 and 1910.

Later American equipments are the Stone-Franklin and E.S.B. The Stone-Franklin equipment is practically the Stone system of Europe improved to meet American requirements. The E.S.B. system, perfected in 1913, makes use of the Rosenberg type of generator.

The practice of mounting generators has been radically different in Europe and America up until the last few years. Most of the European systems mount their generators on the body of the car while the practice in this country has been to mount the generator on the truck. Some of the early American generators were mounted on the body of the car but they soon discarded this method in favor of the truck suspension. In the last few years, however, the use of the body suspended generators has been generally adopted in this country. The Safety equipment was the first of the modern equipments to be suspended from the body of the car, using a special device for constant belt tension.

The Stone-Franklin and E.S.B. generators are also body suspended.

With the generators hung on the truck of the car various kinds of drives were tried, but the present rubber belting has generally been adopted. Some of the methods used were chain belts operated over cog wheels, instead of pulleys; V-shaped leather belting operating in V-faced pulleys, and generator geared to the car axles, on the principle of the trolley car motor. Another method tried was the mounting of the armature on the car axle and the fields on the truck of the car. A body suspended generator was also developed which was driven by a shaft, connected with the axle by cogs. These methods proved unsatisfactory and expensive and were discontinued.

One of the old drawbacks of car lighting was the heavy current consumption of the old carbon lamp, but with the improvements in the incandescent lamp economic car lighting became possible, as the demand on the batteries for current was brought within the necessary limits for battery capacity and weight possible to be carried on a car. Incandescent lamps were used before but did not come into general use for car lighting service until about 1900, and have gradually developed to their present state of efficiency. Another great improvement in car lighting equipment was the perfection of ball bearings for generators. These were first used about 1912 and have been generally adopted since, practically revolutionizing car lighting by cutting down the cost of maintenance.

AN INSTRUCTION SCHOOL FOR ELECTRIC WELDERS

During the development of the extensive shipbuilding program of the Emergency Fleet Corporation the pressing need for electric welders led the corporation to establish several schools for the training of electric arc weld operators. The purpose of the school was to enable men with no previous welding experience to learn the fundamentals of the art in the shortest possible time.

One of these schools was conducted under the supervision of the Lincoln Electric Company, Cleveland, Ohio. Now that the war is over this school has been released by

A Section of the School Equipment for Training Arc Welders

the Emergency Fleet Corporation, and the Lincoln Electric Company is continuing it, putting its service at the disposal of any concern that desires to teach its men the art of arc welding. These men may come to the school and be instructed in any phase of the operation by thoroughly competent instructors. A general idea of the equipment employed for practical instruction work is conveyed by the photograph showing one section of the school with individual operator's sets and switchboards for each operator's use.

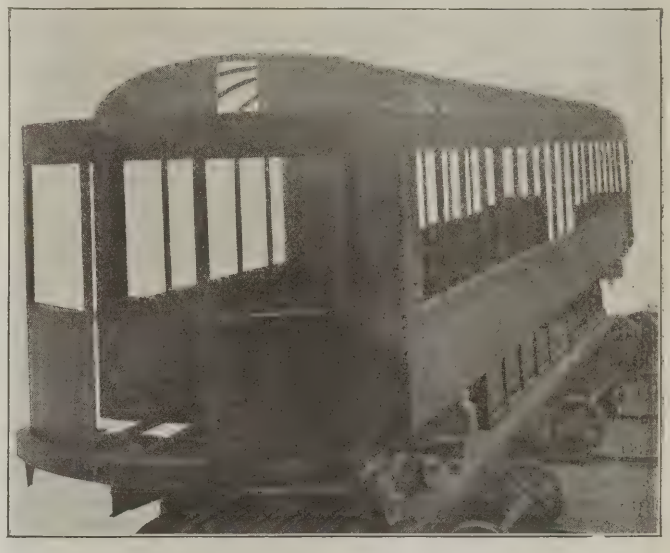
STORAGE BATTERY CARS FOR MEXICAN RAILROAD

The three cars shown in the illustrations have just been delivered to the United Railway of Yucatan by the Railway Storage Battery Company. The cars are driven by motors geared to the axles and power is supplied to the motors by Edison storage batteries. The cars are designed so that they may be operated singly or in multiple unit.

The schedule as laid out for service to be performed, covers the run from Merida to Progreso, a distance of 23.6 miles. There are six stops between terminals and the running time over the line is 45 minutes. The city of Merida has a population of 70,000, while that of Progreso is 8,000. The grade between the two cities is practically level and the total service per day is three round trips. The cars are fitted for passenger service and are able to draw a trailer carrying baggage and express matter.

Construction

The car is constructed according to M. C. B. standards and the car body and its appliances are all steel with the exception of doors and inside fittings. The over-all length of car body is 56 ft., the extreme width is 8 ft. 6 in., and the extreme height is 12 ft. Reversible seats



The Car Bodies and Their Appliances Are All Steel, Except for the Doors and Inside Finish

upholstered with rattan are used and the seating capacity of the car is 66 persons. Brill 69E trucks are used and the couplers, draft gears, and wheels conform to M. C. B. standards.

The total weight of car without load is 28.3 tons; the

Interior of Car Showing Seating Arrangement

batteries alone weigh 6.3 tons and the total weight of the motors and control equipment is about 3 tons. This makes a total weight per passenger of about 500 lbs.

Each car is equipped with four General Electric, No. 261, 250-volt, direct current motors. There is one motor

for each axle and each motor is connected to the axle with a single reduction gear. These motors were supplied to meet the requirements of supplying a single car with 88 mechanical horse-power during acceleration and 28 mechanical horse-power when running free and to supply a car and trailer with 166 mechanical horse-power during acceleration and with 39 mechanical horse-power when running free. The motors are protected by Condit instantaneous, automatic, overload circuit breakers. Double end multiple unit control is used and the cars are connected with a seven-point cable when used in multiple units. The cars are equipped with General Electric straight and automatic air brakes.

Three Storage Battery Cars Just Shipped to the United Railways of Yucatan

Battery

Each car is equipped with a battery of 252 Edison type A-12 cells; 240 of these cells are used for the power circuit and eight for the lighting circuit. While the battery is being charged all of the cells are connected in series. A Sangamo ampere hour meter is installed in the charging circuit to insure the batteries the proper amount of charge.

Performance

These cars are capable of developing a speed of 45 miles an hour on level tangent track. It is possible for them to negotiate grades of from 8 to 10 per cent. and to haul loads of from 30 to 35 tons at a fair maximum speed. They may also be used to sort and drill loads up to 150 tons. Under ordinary service conditions their range of operation on one charge of the battery is about 120 miles.

The particular advantage of this type of car as presented by the maker lies principally in the characteristic of the alkaline storage battery. As the battery is comparatively light in weight, the total weight of the car is not excessive and as the battery is strongly built and not affected by ordinary vibration and shock it lends itself particularly to this class of service. The only attention required for this class of storage battery is to keep it charged and filled with water.

A storage battery, of course, represents a loss of efficiency, but it does away with line losses and where 24-hour service is not required the cost of keeping power on the line with no cars running is eliminated. Furthermore, it is usually possible to charge batteries during an off-peak period and thereby obtain a lower charging rate.

Similar cars are in use on the Cambria & Indiana, the Lorain, Ashland & Southern, the Atlanta, Birmingham & Atlantic, the Chattahoochee Valley, the Long Island and the Pennsylvania. During the mechanical conventions to be held at Atlantic City next June a demonstration car of this type will be operated between Atlantic City and Ocean City.

TEN WAYS TO KILL AN ASSOCIATION

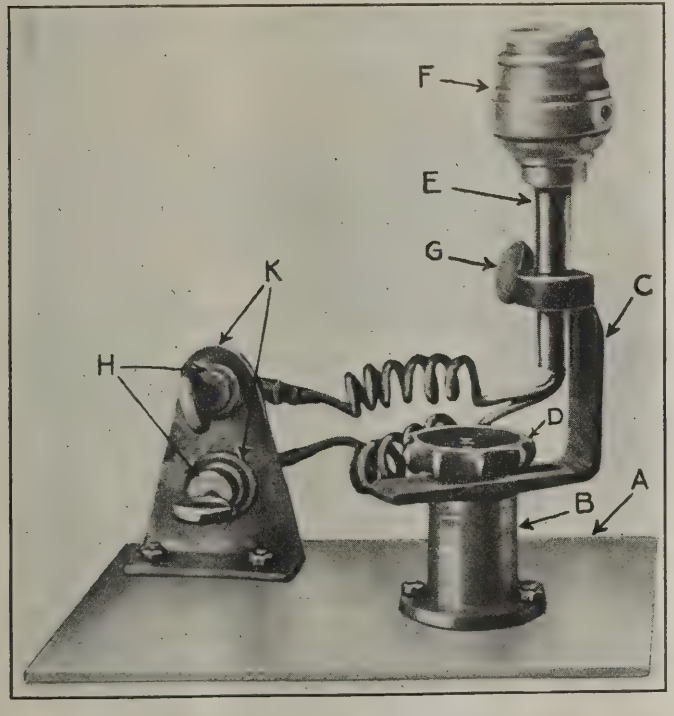
1. Don't come to the meetings.
2. But, if you do come, come late.
3. If the weather doesn't suit you, don't think of coming.
4. If you do attend a meeting, find fault with the work of the officers and other members.
5. Never accept an office, as it is easier to criticize than to do things.
6. Nevertheless, get sore if you are not appointed on a committee, but if you are, do not attend the committee meetings.
7. If asked by the chairman to give your opinion regarding some important matter, tell him you have nothing to say. After the meeting tell everyone how things ought to be done.
8. Do nothing more than is absolutely necessary, but when other members roll up their sleeves and willingly, unselfishly use their ability to help matters along, howl that the association is run by a clique.
9. Hold back your dues as long as possible, or don't pay at all.
10. Don't bother about getting new members. "Let George do it!"—*Builders Bulletin, Wisconsin.*

PRACTICAL STUNTS

Device for Replacing Oil Locomotive Headlights With Electric Lamps

By Walter Woodroofe, Headlight Maintainer, Illinois Central Railroad, Champaign, Ill.

The illustration below shows very clearly one means of substituting an electric lamp for an oil lamp in locomotive headlights. The adjustable bracket carrying the lamp receptacle as well as the support for the terminals for the leading-in wires, are mounted upon a bedplate, *A*, which is 6½ in. wide and 9½ in. long. The stationary part of the bracket, *B*, is secured to the bedplate with



Adjustable Headlight Bracket for Electric Lamps

three bolts. This bracket base, *B*, is made of solid iron and turned in a lathe so that a flange protrudes at the bottom about ½ in. At the top it is tapped and threaded to receive a stud which projects upward through the slot in the adjustable arm, *C*. The upper portion of this stud is also threaded and when the small hand wheel, *D*, is screwed down tightly the bracket may be held in any position desired. The slot in the arm *C* is long enough to allow of a radial adjustment of two inches. The hollow vertical post, *E*, which supports the receptacle, *F*, has a vertical adjustment of 2½ in. and is maintained at the proper height by the set-screw, *G*, The binding posts, *H*, are made of heavy brass and are supported upon the triangular steel plate attached to the bed plate. These binding posts are held in place by means of a bolt which passes through this triangular plate and is secured by means of a nut, not visible in the illustration. The posts are entirely insulated from the plate by means of the fiber washers, *K*, and also by fiber bushings extending through the plate. The entire construction of the device is rugged and durable.

A Brakeman's Method of Repairing Fuses

By J. M. Scudder, Grand Central Terminal, New York

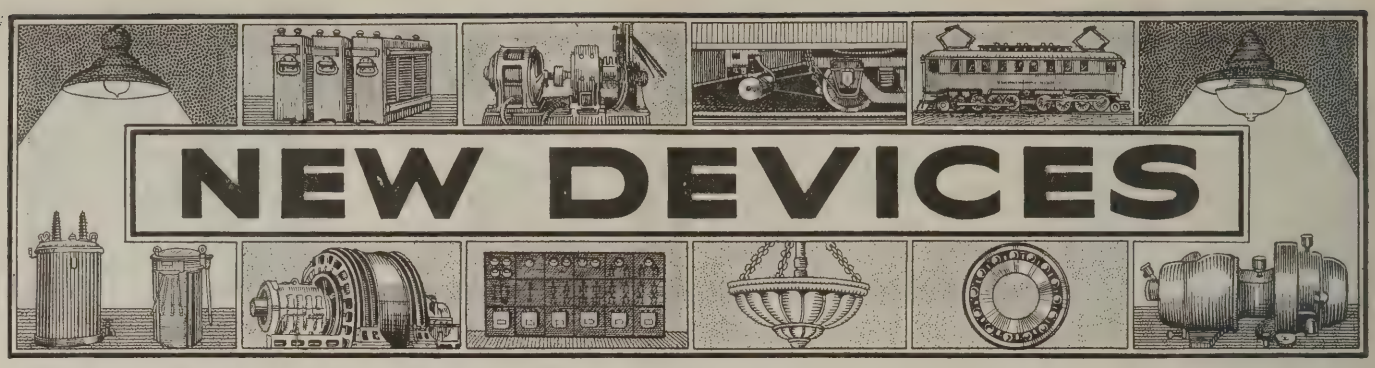
Hinkey Dee, the car lighting expert, has told us that brakemen are the logical source of general information on the subject of car lighting. There are a whole lot of car lighting men who would question such a statement, but an incident which occurred on the New Haven last March indicates that Hinkey Dee has an occasional good hunch.

On the 23d of March one car on train 64 was reported dark. When the repairman reached the train all the cars had light. On investigating he learned that a battery fuse had been blown and that Brakeman Morris had found the trouble, and had remedied it by taking the fuse out, wrapping it with tin foil and replacing it. Mr. Morris is interested in having his train in good condition, and makes a practice of carrying tin foil for repairing damaged fuses. The repairman had no time to do any more work on the car, and let it go out on the road. It came back in good condition, and the wrapped fuse was replaced with a regular 125 ampere fuse.

This method of repair has proved to be practicable in more cases than one, but the most practical idea suggested by it is that car lighting men can co-operate successfully with brakemen, thereby making this easier for both, and preventing possible dark cars on the road. A brakeman who is interested will try to fix the trouble, and if the car lighting man will supply him with the necessary information for such cases as these he can prevent a dark car without damage to the equipment.

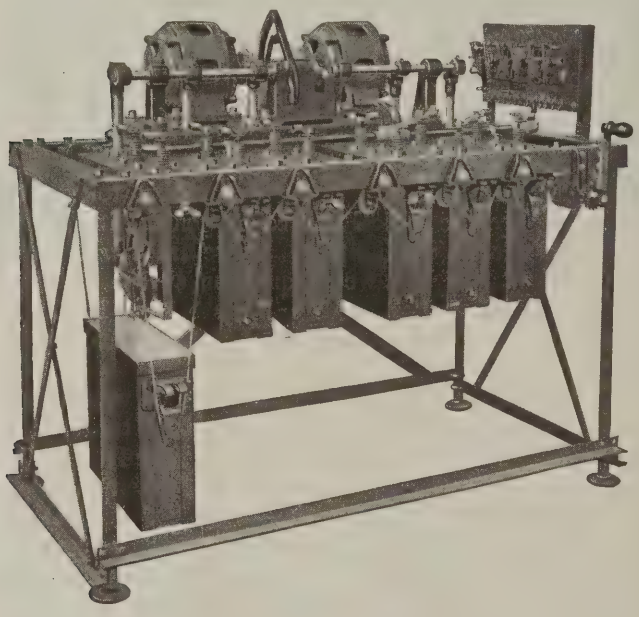
To Soften Putty

To remove old putty from broken windows dip a small brush into caustic soda (concentrated lye) and paint over the dry putty that adheres to the broken glass and frames of your windows; after an hour's interval the putty can be easily removed.



New Oil Reversing Switch for Large Motors

High voltage slip ring motors built for steel mills, mine hoists and similar duty, require some form of switch to connect the primary winding to the lines, especially so when the motor is used for reversing service. The accompanying illustrations show a new primary oil reverse switch that has several new and interesting features. This switch consists principally of two 3-pole switch units each of which is operated by a high torque motor.

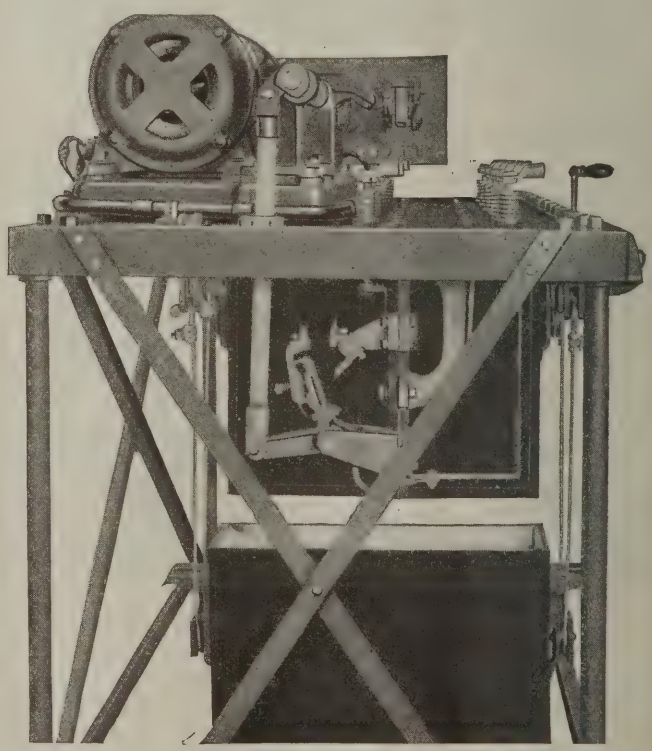


New Primary Oil Reversing Switch Operated by Two High Torque Motors

Among the unique features of this switch are the unit tank construction and the means of lowering the tanks for inspection, repairs and renewal of oil. Unit tank construction is used because it increases accessibility and saves time and labor in locating trouble and making repairs. A double windlass with cables and pulleys permits easy lowering of one or more tanks. In the end view one of the tanks is lowered and shows the simple construction of the stationary and moving members. It will be noted that the arc is broken horizontally rather than vertically. This construction allows the arc to rise to the point of rupture without burning parts not designed for such duty; and since the rupture takes place near the top of the oil, it is well away from all sediment; hence frequent inspections and renewals are unnecessary. The support for the stationary and moving members is bolted to a channel iron which in turn is bolted to the main frame, consequently in case of serious damage to any single pole unit the complete unit may be removed without disturbing any of the others. The tanks surrounding the contacts are lined with a heavy asbestos material to prevent groundings of any live parts in case the tank is pushed out of place and also as an additional safeguard in case of sludging of the oil.

The contactor panel shown at the extreme right is controlled from a master switch or push buttons and handles the motor currents. Very little current is required as the motors used to operate switch have high resistance motors.

This particular reversing switch was made by The Cutler-Hammer Mfg. Co. of Milwaukee for a 1200 hp. 220 volt mine hoist motor. It may be used for two motors on non-reversing service, or where only one non-reversing motor is required the switch is made with only one 3-pole unit and one motor.

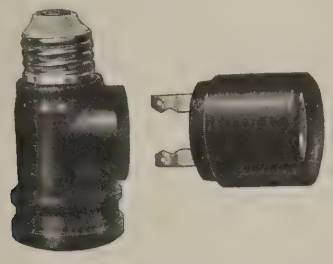


End View of Reversing Switch Showing Construction of Contact Members. The Arc Is Broken Horizontally

A New Current Tap

The No. 6700 Current Tap is a recent addition to the line of electrical wiring devices manufactured by Harvey Hubbell, Inc., Bridgeport, Conn. This is a combination of a current tap body and lamp receptacle. Both are made of heat-resisting composition.

This current tap not only provides an extra source of current supply without interrupting the service from the lamp, but the additional outlet will take all standard plug



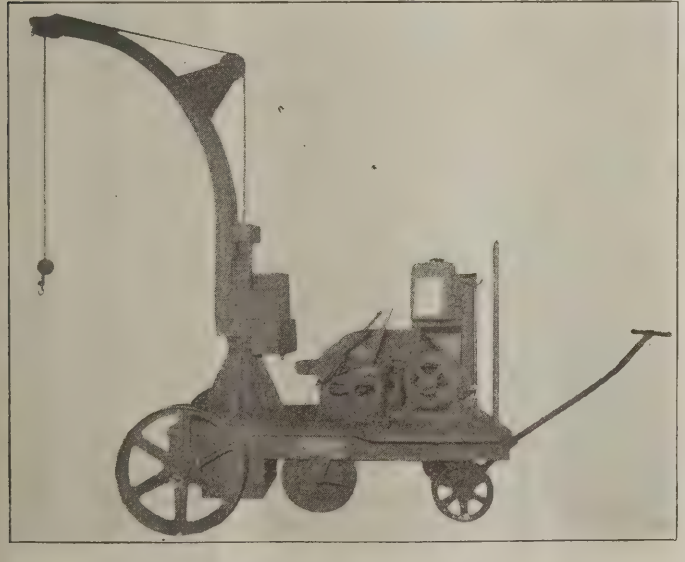
Current Tap and Screw Base Plug

caps or any one-piece screw base plug. This feature is an advantage since it doubles the scope and utility of the device.

Another feature is found in the fact that the lamp hangs in the correct, vertical position and the tap is so designed as to allow the use of glass or metal reflectors. The manufacturers believe that the new current tap will become exceedingly popular, as it can be used in buildings of every description where electrical current is available.

A Portable Electric Stacking Crane

An electric stacking machine designed for use in freight terminals and warehouses which can be wheeled from place to place and which is equipped with a conductor



The Crane Is Readily Moved from Place to Place

reel so that the conductor may be connected with plugs in the various parts of the house and the current thus carried to the motor on the crane is shown in the photograph. These cranes can be operated either by direct or alternating current and are made in capacities up to one ton. They are designed for high speed work, usually having a hoisting speed of from 150 to 200 ft. per minute except in the case of short lifts, when the speed is lower.

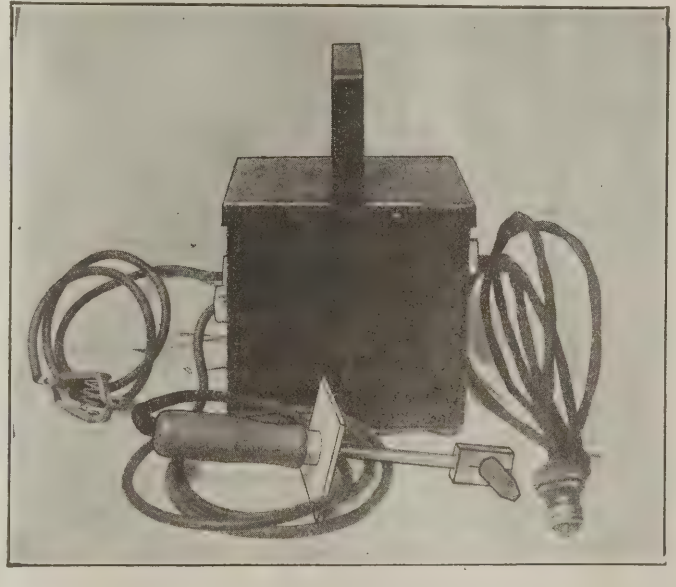
The boom or tower can be made up to 25 ft. high and may be swung either by motor or by hand. In special installations the truck can be driven by motor and the boom may be hinged so as to permit passage through low doorways.

The principal installation of these cranes in this country is on the Boston terminal wharf. Installations have also been made at various points in Cuba. The cranes are manufactured by the Northern Engineering Works of Detroit, Mich.

Electric Lead Burning Set

The new electric lead burner outfit illustrated below has recently been placed on the market by the Spence Electric Company of New York.

The outfit has been developed to meet the demand for a cheap and convenient means of burning or welding the straps and posts on storage batteries, and for all



Electric Lead Burning Outft

lead burning work where the gas burner is not available. It is particularly adaptable for use in the garage or in the battery repair station. The set may be connected to any electric light socket on the 110-volt alternating electric lighting system and is operated in a manner similar to that of an electric soldering iron. Any degree of heat may be obtained and readily controlled by simply varying the pressure at the point of contact. One of the chief advantages of the outfit is that a skilled operator is not required as in the case of the gas flame outfit. Practically anyone can operate the set. There are no gas fumes to contend with.

The current consumption is comparatively low and is about equal to that of a 300-watt electric lamp, or in other words, the cost of operation is about five cents per hour on a basis of an electric power charge of 10 cents per kilowat hour.

General News Section

Edison Storage Battery Company, Orange, N. J., has issued a new price list, effective March 1, reducing the price of types A, B and G Edison cells approximately 16 per cent. This company is also boosting prosperity by using the slogan, "Procrastination murders industry —stir things up!"

The Construction of a Tunnel, for automobiles, beneath the Hudson River, between New York City and Jersey City, seems to be assured by the action of the legislature of New York, which has made an appropriation of $1,000,000 for the beginning of the work. The governments of New York and New Jersey appear to be substantially agreed as to the general plans. The estimated cost of the tunnel is $12,000,000, and the time necessary for the construction about two years.

The Strike of 1894 figures in a suit now on trial in Chicago. After 25 years, the suit of the Yazoo & Mississippi Valley, now operated by the Illinois Central, against the city of Chicago for $20,000 damages has been brought to trial before Judge S. T. Page in the United States Circuit court. The suit is for loss by the destruction of freight cars at the time of that noted strike when federal troops were called to guard property. Many of the witnesses called at the opening of the court were reported dead.

The Chicago section of the American Institute of Electrical Engineers and the electrical engineering section of the Western Society of Engineers held a joint meeting in Chicago on April 28. An interesting paper on "Wireless Telephony and Telegraphy in the War" was presented by A. A. Oswald of the Western Electric Company, New York. Mr. Oswald, during the war, was research engineer on the development of wireless telephony and telegraphy. He treated in a general way the apparatus which has been developed and its various uses in connection with military and naval warfare for land, air and water service. A number of slides were shown to illustrate the various types of apparatus in use and the diagrammatical charts of the sending and receiving stations in the fighting zones.

Portable ticket cases are now in use at the Grand Central Terminal, New York City—large cases, each with room for all of the forms used at that station, mounted on casters so that they can be moved from one window to another. This office carries about 3,000 forms and under ordinary arrangements the ticket sellers have to do a large amount of walking from one case to another. In the new cases all very long tickets are folded so as to occupy the minimum amount of space. Each clerk, having a case assigned to his individual use, is provided not only with all forms of railroad tickets, but also with Pullman tickets. The standard case, when shut up, is 3 ft. 9 in. wide, 2 ft. deep and 7 ft. high. By making all tickets with stubs, so as to simplify the accounting, one case is used, where necessary or desirable, by two sellers simultaneously. The simplification of the seller's work by the use of these cases has greatly relieved congestion at the ticket windows. The New York Central uses at the Grand Central Terminal 13 ticket windows.

The Pennsylvania Railroad is building an 11,000-volt power line from South Altoona to Altoona and is installing at that place the first unit in a centralized power station that will do away with the plants at Twelfth street, Fourth street and Juniata. These plants will be retained only to generate steam for heating and the operation of steam hammers. The installation of the new system, on which work is already well under way, will involve the placing of two 5,000-kw. generators and auxiliary machinery at the new South Altoona plant, the power line of all-steel construction, and sub-stations at South Altoona, Twelfth street, Fourth street and Juniata. At these places transformers will step down the current to the voltage needed to operate at that particular place. The change, which involves the expenditure of many thousands of dollars, will be completed in the early summer. Although the new system is being installed as a matter of economy, it will incidentally be a very material aid in lessening the smoke nuisance in Altoona.

Semi-Annual Meeting of the A. R. E. E.

Arrangements have been completed to hold the semi-annual meeting of the Association of Railway Electrical Engineers at the Hotel Denis, Atlantic City, N. J. The meeting will be held in the Children's Play Room of the Hotel Denis at 9:00 a. m., Monday, June 23.

Progress reports of all committees which are to report at the annual convention in October, 1919, will be gone over and discussed in order to bring out any questions and information so that the committee reports will be complete for the annual meeting.

The completed report on Electric Headlights, making recommendations for proper methods of installation and wiring will be presented at this meeting for acceptance. This report has been accepted by the Committee on Electric Headlights for the Master Mechanics' Association and will be presented in its entirety before the Master Mechanics' meeting at Atlantic City.

Every member of the association should make arrangements to attend the semi-annual meeting this year, above all others. Much benefit is certain to be derived by active participation in the discussion of the various committee reports. Now that the war is over there is reason to believe that the exhibits will, this year, surpass in every way those of previous years. The opportunity of viewing them is something that should not be neglected by any railroad man.

Ball Bearing Manufacturers Combine

Of interest to all users of bearings is the just announced reorganization, effective May first, whereby the products of The Hess-Bright Manufacturing Company, the S K F Ball Bearing Co., the Atlas Ball Company and the Hubbard Machine Company will be sold through one central organization. The new company, under the name of S K F Industries, Inc., will thereby be able to offer a comprehensive line of ball bearings, including the Hess-Bright deep-groove type, S K F Self-aligning radial and thrust bearings and ball bearing pillow-blocks and shafting hangers.

Through the medium of its engineering organization, backed up by a well equipped laboratory, the new company will be able to place at the service of bearing users the knowledge gained in many years' study of anti-friction bearings of all kinds. On request, manufacturers' problems will be analyzed in detail and that type of bearing recommended which (independent of sales considerations) is best suited to the conditions met. In addition the laboratory staff will carry on research studies affecting anti-friction bearing design and application.

The new company—S K F Industries, Inc.—will be under the direction of B. G. Prytz, President; W. L. Batt, Vice-President, J. P. Walsh, Comptroller and S. B. Taylor, Sales Manager. The principal office will be at 165 Broadway, New York City, with branches at Boston, Philadelphia, Atlanta, Buffalo, Cleveland, Detroit, Cincinnati, Chicago, and San Francisco.

Electrical Night at the Western Railway Club

The Western Railway Club held its first electrical night on April 21, at the Sherman Hotel, Chicago. The paper presented at the meeting was "Electrification of Trunk Line Railroads," by W. B. Potter and S. T. Dodd, both of the General Electric Company.

Among other things brought out by the paper it was shown that the United States contained more electrified main line railroad than all the rest of the world combined. Some 675 electric locomotives are operating over 4,875 miles of route or 8,300 miles of electrified track as compared with the remaining electrified lines of the world which only total approximately 1,000 miles of route or 1,750 miles of track, over which 450 electric locomotives operate.

In stating the reasons for electrification the elimination of smoke in tunnels and terminals was given as being the primary object of these electrical installations. Attention was drawn to the fact, however, that the recent enormous demand for coal for use on locomotives has caused this matter to be given greater consideration than heretofore. It is estimated that by using coal for the generation of electric current at central stations to be used for electric traction purposes, 100,000,000 tons of coal could be saved each year. Furthermore, if the water power resources of the country were utilized, the saving in coal would be still greater.

A portion of the paper was devoted to the design of locomotives in which the various types of American and European locomotives were compared.

In the matter of collecting current from the trolley wire the superiority of the pantagraph collector was made apparent. Although considerable experimenting had been done in the way of using rolling and sliding contact it was shown that the latter has proved to be decidedly superior. Moreover, the lubrication of the sliding contact shoe not only reduces the wear on both the shoe and trolley wire but also appeared to improve the contact. Currents as high as 2,000 amperes have been collected successfully at speeds of more than 60 miles per hour.

The subject of regeneration, which is of great interest to lines operating in mountainous districts, was also touched upon. It was shown that regenerative braking eliminated the surging in the train and variations of speed which are encountered in the use of air brakes. Furthermore, there is a decided saving in brake shoes and the use of regenerative braking permits the air reservoir to be fully charged so that it may be used in case of emergency. Finally, in the point of economy it was shown that a train on a 2 per cent grade has regenerated 42 per cent of the power required to pull the same train up the same grade. Records for particular months over the entire Rocky Mountain division of the St. Paul for both freight and passenger trains show that the regeneration is equivalent to 11.3 per cent of the total power used.

June Signal Meeting

The next meeting of the Signal Division of the American Railroad Association (formerly the Railway Signal Association) will be held at "The Breakers," Atlantic City, N. J., on Thursday and Friday, June 26 and 27. The Journal of Proceedings, containing the reports of committees which will be dealt with at this meeting, is to be issued about June 7. Members are asked to make their reservations at the hotel at an early date. The rates at the hotel range from $3.00 a day, European plan, for a room without private bath, occupied by one person, to rooms with private bath, occupied by two persons, at $7 to $14; and, on the American plan, from $6 or $7 a day for room without private bath, occupied by one person, to $20 for a room with private bath occupied by two persons.

H. S. Balliet, secretary of the signal division, announces the removal of his headquarters, on May 15, from Bethlehem, Pa., to 75 Church street, New York City.

PERSONALS

George H. Kelsay, electrical engineer of the Union Traction Company of Indiana, has resigned to go with the Cleveland Southwestern & Columbus as superintendent of power and equipment, with headquarters at Elyria, Ohio.

O. A. Niedermeyer, formerly in the employ of the Safety Car Heating & Lighting Co., at Chattanooga, Tenn., has been appointed foreman of the electrical department of the Kansas City Terminal railroad with headquarters at Kansas City, Mo., vice W. J. Dawson.

W. J. Dawson has been appointed chief electrician for the Kansas City Terminal railroad at Kansas City, Mo. Mr. Dawson succeeds L. D. Smith, who has entered the employ of the Chicago, Rock Island & Pacific and is located at Sylvis, Ill. Mr. Dawson is to be con-

gratulated in having worked up from the ranks, being promoted to his present position from that of foreman.

IRA R. WENTWORTH, formerly in the employ of the New York Central railroad at Chicago, on car lighting, and more recently employed by the Willard Storage Battery Company at that point, has accepted the appointment as supervisor of electric headlight equipment, with office at Cleveland, Ohio, under the direct supervision of H. C. Meloy, supervisor of electrical appliances.

FRANK B. JEWETT, chief engineer of the Western Electric Company and late lieutenant-colonel in the Signal Corps, U. S. A., has been awarded the Distinguished Service Medal. The presentation took place at Washington, D. C., on Saturday, April 5.

F. B. Jewett

The official citation follows:

"By direction of the President and under the provision of the Act of Congress, approved July 9, 1918, the Distinguished Service Medal is awarded to the following officers and civilians for exceptionally meritorious and conspicuous service:

"Mr. Frank B. Jewett, late lieutenant-colonel Signal Corps, for exceptionally meritorious and conspicuous service in connection with the development of the Radio Telephone and the development and production of other technical apparatus for the Army."

Dr. Jewett, shortly after the United States entered the war, received a commission as major in the Signal Officers' Reserve Corps. His promotion to the rank of lieutenant-colonel followed in the early part of 1918.

TRADE PUBLICATIONS

Wheeler Reflector Company, Boston, Mass., has recently issued a small 8-page illustrated folder describing the various types of incandescent lamp fixtures. Both canopies and reflectors are shown.

Franklin Specialty Manufacturing Company, New York, is distributing its 36-page catalogue in which are illustrated and described its very complete line of adjustable brackets for use in connection with incandescent lamps.

American Lava Company, Chattanooga, Tenn., has recently issued a 16-page illustrated catalogue entitled "Lava for Mechanical and Electrical Purposes." The book illustrates the many uses for this material as well as giving its mechanical and electrical properties.

The Thompson Electric Company, Cleveland, Ohio, is distributing a small envelope folder entitled "How to Make Reflectors Reflect." The folder shows a number of illustrations of undesirable lighting installations in which are brought out the conditions to be avoided.

Page Steel & Wire Co., New York, are distributing a small illustrated combined handbook and catalogue, entitled "Armco Iron Rods and Wire." The book contains much useful information on the subject of oxy-acetylene and electric welding.

The Loco-Light Company, Indianapolis, Ind., is distributing two envelope folders illustrating and describing the headlight equipment which it manufactures. The folders contain a number of photographs and sectional drawings showing the various parts of the generators and turbines.

Malleable Iron is the name given to a booklet that is being distributed by the American Malleable Castings Association of Cleveland, Ohio. The object of the booklet is to inform the public regarding the progress that has been made in the use of malleable iron during the last few years. Although the booklet is but a forerunner for a very comprehensive volume to be issued later by the Association, it is filled with the most valuable data.

Schweitzer & Conrad, Inc., Chicago, are distributing their catalogue of high voltage protective and switch equipment. The apparatus listed in the book is very well illustrated and described. Several of the devices which have recently been perfected are the safety disconnecting switches, the high voltage circuit breakers, ejector primary cutouts, and form 3A-Type H. lightning arresters. These have been perfected as a result of careful study and intimate contact with the actual operating conditions.

Western Electric Company, Inc., New York, is distributing an illustrated pamphlet entitled "Some War Time Contributions to Scientific Advancement." The booklet contains 30 pages and is devoted to the description of wireless telephone apparatus which was perfected by men in the employ of this company and which was used so successfully in communicating between the ground and airplanes during the war. Quite a number of other subjects related to this work are also described and illustrated.

Schroeder Headlight & Generator Co., Evansville, Ind., is distributing a booklet entitled "The Modern Locomotive Headlight." The book is designed with the idea of giving headlight maintainers, mechanical and electrical officials some real pocket information in addition to giving complete descriptions and illustrations of the Schroeder Sunbeam Type RE-3 and pattern No. 1030 incandescent electric headlight equipment. It is a treatise on modern locomotive headlight equipment for the reason that it shows the manner of wiring locomotives, kind of wire to use, the properties of steam, properties of copper wire, methods of taking care of the commutators and brushes, kind and sizes of lamps to be used in the headlights, as well as the care of the reflectors, lamps, etc. Lastly, the kind and number of tools with which headlight maintainers should be equipped. The information applies to any manufacturer's headlights as well as to the Schroeder.

Railway Electrical Engineer

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HIGHER SALARIES FOR ENGINEERS

"Where ignorance is bliss 'tis folly to be wise." Of what value is a technical education to an engineer, or further still, what is the use of becoming an engineer at all when John Jones, a shop mechanic, and Sam Smith, a bridge carpenter, to whom the mere signing of the pay-roll is a mental as well as a physical effort, receive as much for their services as does the engineer upon whom the successful construction and operation of the road depends? Where is the incentive for a man to spend four years in college acquiring a specialized training, to say nothing of the money that it takes to keep him there, only to find when he takes up his profession that he could have earned as much or more had he never gone to school at all?

The whole trouble with the engineering profession is that it has given too little consideration to a just and compatible compensation for services rendered. It is not an unusual thing for a temperamental artist to refuse to commercialize his talent and remain in poverty while waiting for recognition that never comes, but such hypersensitive sentiments should have no place in the engineering profession. Of all men the engineer is the man who should have sound practical sense, but until recently in general there has been very little evidence of any application of this quality to his own personal economic welfare.

The economic conditions that have developed in the past year are such that the engineering profession has been forced to the realization of its utterly inadequate compensation and it is particularly gratifying that some definite steps have been taken to relieve the undesirable situation, so far as it concerns the railroad field.

A few weeks ago representatives from two organizations proposing to remedy the existing state of affairs presented their respective pleas before the Board of Wages and Working Conditions at Washington. One of these groups composed of members of the four national engineering societies (Civil, Mechanical, Electrical and Mining), together with the American Society for Testing Materials, is known as Engineering Council. The second group, composed for the most part of the younger engineers, has been organized as the American Association of Engineers. While the two organizations have principally the same object in view they differ considerably in their means of accomplishing the desired results. Engineering Council is apparently content in making its appeal to the Board of Wages and Working Conditions and allowing the matter to rest with the Board, whereas the American Association of Engineers, being organized for the express purpose of furthering the social and economic welfare of its members, is carrying the matter a step further by building up an organization strong enough to compel recognition. In this respect it has been compared to the trade unions, but there is little danger of such an organization adopting the policies of the trade unions.

It has been argued that the standardization of positions and wages which the Association advocates would tend to stifle initiative and individual ability, but this is not necessarily the case, especially in an association of professional men. The subject is one which comes home to a very large number of members of the engineering profession. The practice of penalizing a man because he has taken the time and spent the money to obtain an education belongs to the past, and it is up to the engineers themselves to see that the matter is satisfactorily adjusted.

THE EXHIBITS AT THE CONVENTIONS

There is a certain amount of psychology behind the letter which Frank McManamy, assistant director of the Division of Operation, recently sent to the regional directors, suggesting that they urge the roads to send as many representatives to the June mechanical conventions as possible. Mr. McManamy further suggests, and it is in this suggestion that the psychology lies, that each representative present below the rank of superintendent of motive power shall render a written report to his superior of those things which he observed that interested him most and which might be of value to his particular road.

To comply with this suggestion means that each man affected will be practically obliged to make notes of the various exhibits in order that he may make a comprehensive report. It is really surprising how much the mind retains of a subject that has once been recorded on paper. The suggestion is bound to be productive of much benefit to all concerned as it emphasizes one of the real objectives of the convention and it is certain to stimulate an interest in the exhibits that might otherwise in some cases be superficial. The Railway Supply Manufacturers Association is planning to co-operate with the movement by supplying notebooks specially adapted to the convenience of the railroad officers.

While the semi-annual meeting of the Association of Railway Electrical Engineers is of shorter duration than either that of the Master Mechanics' Association or the Master Car Builders' Association, the advantages gained by the visit of the electrical men to Atlantic City should by no means be measured by the length of their own

particular convention. Many of the exhibits will be of such interest and importance that the fact that they are mechanical devices rather than electrical may well be lost sight of. A clear understanding of mechanical apparatus is desirable. There is an unfortunate tendency among electrical men to avoid those things which are purely mechanical. This is a decidedly mistaken attitude, for their are few so-called electrical devices that are not to a very large extent mechanical.

The exhibits this year at Atlantic City will be worth all the time that can be spent on them. The electrical engineers cannot be too strongly urged to make the most of the opportunity to see and study not only the apparatus that is essentially electrical, but that which is wholly mechanical as well.

LOCOMOTIVE ELECTRIC HEADLIGHTS

The installation of electric headlights is steadily going on and by the time another year has rolled around practically every locomotive in the country will be equipped with these high power outfits.

The advantages derived from the use of electric light equipment on the locomotives are so well known that it is quite unnecessary to mention them here, but the fact should be kept constantly in mind that these advantages can be enjoyed only when this equipment is maintained in perfect operating condition. Careless and haphazard methods of installation are certain to bear fruit in a never-ending series of failures. It is not putting it too strongly to say that it is almost impossible to spend too much care in the selection of material and on the installation of it. It must be remembered that the entire equipment is subjected to conditions which will tend to break down any weak spot in the installation.

Once the outfit is installed, however, the problem becomes one of maintenance. If the installation has been made with care, using high grade materials, the matter of maintenance should be comparatively simple. This does not mean that the equipment should be turned loose to operate until a failure develops. The best performance of electric headlights, the lowest maintenance cost, and the longest life of the equipment will be found on those roads which give the matter of caring for these equipments the attention it deserves. An organization perfected for the purpose of maintaining electric headlights and adhering to established rules and regulations will be able to secure the advantages which are inherent in the installation. Systematic inspection and methods of record keeping that will insure each outfit receiving periodical attention will not only keep the maintenance cost down but will result in obtaining the maximum efficiency from the equipment.

On page 186 of this issue of the *Railway Electrical Engineer* the rules and regulations which have been adopted by the Cleveland, Cincinnati, Chicago & St. Louis are given. Other roads operating under different conditions will probably find a different scheme to their advantage. The particular method is not so important. Each road will adopt its own maintenance plan and if these plans are such that each outfit receives the attention it should the result will be reflected in the excellence of the headlight service; on the other hand if the maintenance plan is inadequate poor results will inevitably follow.

THE DEVELOPMENT OF THE TURNTABLE

Sixty horsepower seems like a large amount of power to use for moving a turntable, but the Pennsylvania has decided that with its new 110 ft. tables it is warranted in using this amount of power. At one time wooden turntables of the "A" frame type supported the heaviest locomotives, while man power was used to turn them. A few men were usually detailed for this operation, but sometimes it necessitated the aid of the whole roundhouse force.

Steel tables replaced those of wood and steam and air operated tractors were used with varying degrees of success, but finally electric power was decided upon as the most satisfactory. The electrically driven equipment consists for the most part of a single tractor with the operating cab mounted on it on one end of the table, while the most common type of current collector is hung from overhead wires. At first the tractor and the end trucks of the table ran on the same rail. The end trucks had to be dragged over the sand used to increase traction on the tractor and this caused trouble. A second circle rail and in a few cases a rack which meshed with a gear on the tractor were used to overcome the difficulty.

Up to the present time all improvements have been applied to tables of the balanced type on which it was necessary to spot the locomotive before the table could be turned. Such tables are also subject to warping which makes it difficult to line up the table at both ends with a through track. Derailments, putting the table out of service, and causing serious interruption of traffic, have resulted from this.

The table described in this issue has met all these difficulties and its development has brought out several new applications of interest to the electrical men. For example, the collector is mounted rigidly on the center portal; and the controller which operates both tractors can be used on any type of motor that it may be desirable to install.

NEW BOOKS

Trautwine's Civil Engineer's Pocketbook. Twentieth Edition, by John C. Trautwine, revised by John C. Trautwine, Jr., and John C. Trautwine, third. Bound in flexible leather, 6 in. by 4 in., 1528 pages. Published by Trautwine Company, 257 South Fourth street, Philadelphia. Price $6.

The first issue of the twentieth edition of this well-known reference to civil engineering constitutes the 140th thousand. Aside from a desire to bring the work up-to-date, the object of this revision is to extend the section on railway engineering.

Passenger Train Resistance. By Edward C. Schmidt and Harold H. Dunn. Bulletin of the University of Illinois Experiment Station; 44 pages; published by the University of Illinois, Urbana, Ill. Price 20 cents.

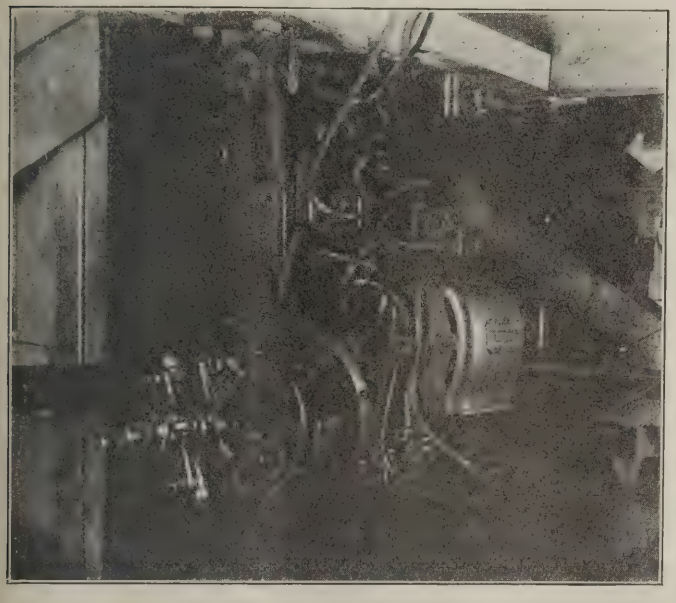
This constitutes a report on tests made of passenger equipment on the Illinois Central at all speeds up to 70 miles per hour and covering all ordinary weights of equipment in common use. The tests were all made on well maintained main track laid with 85 and 90 lb. rail and in fair and moderate degrees of warm weather. The results, presented in the form of a series of charts and tables, are considered as applicable without modification to trains running under like conditions of track and weather.

How One Road Tests Its Axle Generators

The Grand Trunk Solved the Problem by Installing Apparatus in its Elsdon Shops at Chicago

By J. Doornhein*

IN view of the fact that uninterrupted service in the electric lighting of steam railway cars is one of the many things connected with railroads which helps to keep up the standard demanded by the traveling public, and also because the service rendered by car lighting equipment depends largely upon the care it receives both while in use on the road and while undergoing repairs in



The Stone Generator Showing Automatic Switch Board and Governor Exposed

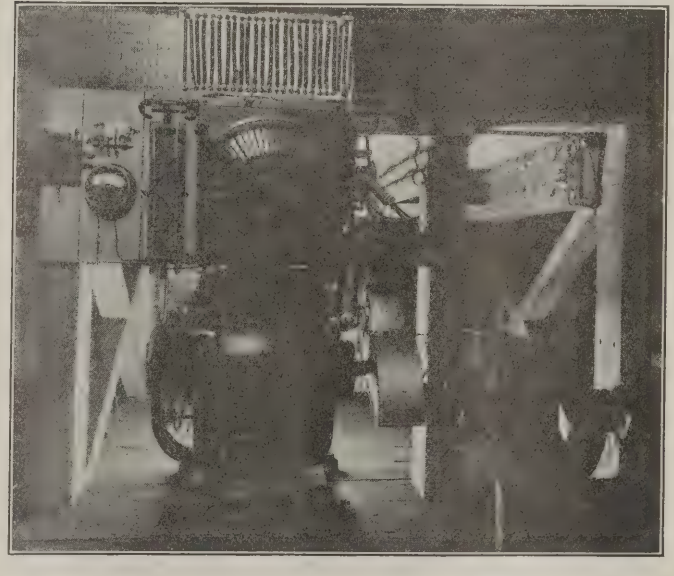
the shops, the Grand Trunk Western Lines has developed and installed suitable apparatus for testing both regulators and generators used on its system. The testing equipment has been designed to operate under all the varying conditions of speed, stop and reversals, the same as in actual operation.

The Stone System

The prevailing system of car lighting on the Grand Trunk is that known as the "Stone," which depends upon belt slippage for voltage regulation. The generator is suspended from the car body by means of an adjustable link in such a manner that it hangs diagonally until drawn into the horizontal position by a belt, which is held taut by the weight of the generator; no belt tension spring is necessary. The adjustable link provides a means of adjusting the belt tension to insure slippage when the train exceeds a certain speed. One of the illustrations shows the generator hung from the testing frame in about the correct position for operation.

The Test Equipment

In order to meet the requirements of the "Stone system" it was necessary to provide a testing frame which would approach, as nearly as possible, the conditions existing on cars. The frame is composed of 5 in. by 9 in. pine sills thoroughly braced and built to give about the same height between the floor and the upper portion of the frame as exists under the frame of a coach and the roadbed. At one end of the frame a countershaft is mounted and provided with a 17 in. pulley corresponding to the axle pulley on a car. This countershaft is geared to a d. c. motor and is so located with respect to the generator that the distance between the generator pulley and the 17 in. pulley on the countershaft is 5 ft. 4 in. which is about the same as it is on coaches. It is quite obvious that this distance should be maintained in a test equipment where slippage depends upon the operating conditions of the equipment. In order to obtain the speed variation which exists on a railroad a speed starting rheostat is used with the test equipment. This rheostat is arranged so that the speed may be gradually increased from 5 to 70 miles per hour. Means have been provided also for controlling the direction of rotation. This is accomplished by a double throw double pole switch connected in series with the armature circuit of the motor. In order to regulate the speed in a manner which would approach as nearly as possible the train-speed, additional resistance had to be inserted in the armature circuit of the motor and so connected with the resistance of the speed starting rheostat as to permit the additional resistance being cut in or out as required.



Motor and Control Apparatus Including Lighting Equipment and Lamp Bank

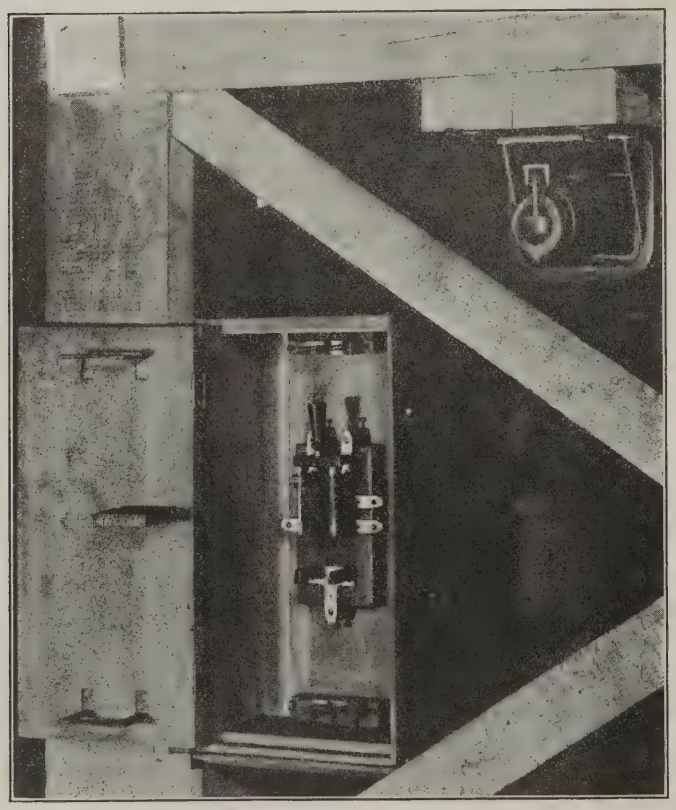
The frame work of the test equipment is wired to correspond with that in the coaches and includes all of the devices used in connection with the lighting system. The diagram of connections shown in one of the illustra-

*Electrician foreman, Grand Trunk Ry., Chicago.

tions is complete in every detail in so far as the apparatus can be represented graphically. Two lamp banks of 16 lamps each corresponding to the light circuit in the coaches is also included. One of these banks is shown in one of the illustrations. There is an exact duplicate of this bank on the opposite side of the frame, invisible, however, on account of the supports holding other apparatus. At one end of the lamp bank is shown a double pole throw switch. Each bank is equipped with such a switch for the purpose of changing from the Stone equipment to the Consolidated equipment. The latter equipment when tested is driven by the same motor by means of the belt which is shown in the illustration hanging loose from the countershaft. Methods of testing consolidated equipment will be described in a later issue of the *Railway Electrical Engineer*.

Instructions for Operation of Main, Trainline and Battery Switches

In connection with the test equipment it is necessary to operate the switching apparatus similar to that in actual operation and it might be well, therefore, to briefly describe and illustrate the Grand Trunk's method of instructing those in charge of operating the lighting



Battery Switch and Charging Receptacle

switches. Blue prints are mounted in a frame beside the switch cabinets in each coach. These show the switch symbols, given in the illustration, together with the following information.

Main Switch

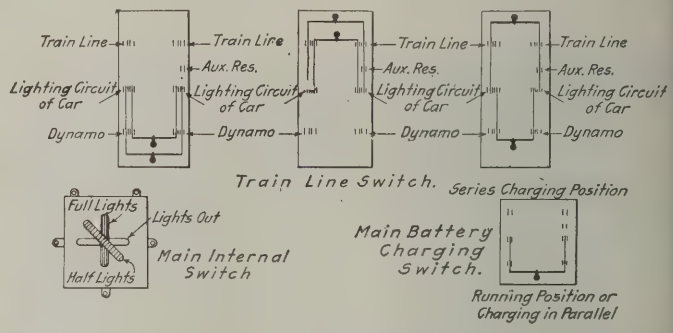
For half light turn switch to position marked "half light." For full light turn switch to position marked "full light," for lights out turn switch to position marked "lights out."

Train line Switch

To light this car only, both switch handles must be down as shown in position 1. To obtain light from another car both switch handles must be up as shown in position 2. To light this car and another car long switch handle must be up, short switch handle down as shown in position 3.

Battery Charging Switch

To charge battery in series throw switch into upper contact; this connects batteries in series for 60-volt charging (door must be left open while charging) red light in switch locker will be lighted while switch is in this position, green light will be lighted when switch is



Method of Operating Switches

thrown into the lower contacts, which is the running position. Electricians must be sure to throw switch down after charging, then lock the door, otherwise the generator will not charge the battery and the cars will be without light when standing. Note; it is imperative that both handles of trainline switch are up in defective cars while obtaining current from another car. Car cleaners will use switch marked car cleaner. Trainmen and others are asked not to waste the light by unnecessary burning. On 30-volt system trainline must not be used on headend system.

Value of Testing Equipment

The requirements of any device or combination of devices for testing the operating characteristics of a system of circuits and appliances, designed to perform certain functions, depend largely on the nature of the tests to be made and the extent to which they are to be carried out. In most cases, however, the testing equipment should be designed to permit tests to be conducted under conditions which approach the actual service operation as nearly as possible.

The advantage of providing equipment in the shop for testing axle generators should by no means be lost sight of, for there are many tests that can be carried on in the shop on such apparatus that cannot be done successfully otherwise. The testing equipment on the Grand Trunk described above permits tests being made to determine the exact tension of the belt necessary to produce the proper output of the generator. New, repaired, or rewound armatures are tested accurately. Arcing commutators are quickly discovered and the proper remedies applied, thus preventing what might later develop into irreparable damage. The automatic switch board with all its adjusting parts (which is attached to the generator and enclosed by a hood or dust cover) is completely exposed while tests are being made, thus bringing into view

the swivel switch, the short circuiting lever, the pole changer, the friction gear, the governor which determines the cutting in speed of the train, resistance units and other parts, all of which can be examined closely; permitting adjustments to be made and defects remedied by the electrician, with perfect safety to himself and with no annoyance to passengers. Furthermore, possible defects in design become apparent and remedies are suggested and tried out, resulting in gradual improvement of the car lighting equipment. It may not be out of place to add that any improvements suggested by Grand Trunk electricians are duly credited and considered when promotions are made.

As explained above the automatic switch board and governing device are exposed when tests are made in the shop so that if the governor is improperly adjusted for train speed the proper adjustments are made. Other adjustments also may be necessary; for instance, the rocking arm spring might be weak. Sometimes when this spring is new it is too strong. The contact combs might be spread too much or not enough, or they may be too long; such a condition was discovered in a new contact comb recently applied. The comb contacts might not be in line, causing the combs to jam. Whenever an automatic switch board and its housing or resistance units are repaired they are given a thorough test before applying them on the equipment installed on a couch. Other defects such as the following can be easiiy and quickly discovered in making shop tests: Eccentric commutators, flat spots, sprung armature shafts, on either the commutator or pulley end; loose commutator connections, short circuits or grounds which are not detected by the ordinary test methods, frequently develop on repaired or new commutators and armatures after being in service a few hours on the testing apparatus.

Any of these cases of trouble, besides many others, which cause light failures cannot be determined or located with any degree of certainty by riding a car running 30 to 60 miles an hour, they can, however, be ascertained with accuracy when tested by means of equipment in the shops. Sometimes tests are necessary to prove or disprove certain theories which require long drawn out experiments if carried on while riding passenger cars. Such tests would be annoying to the passengers and extremely wasteful of time and labor. With the shop testing equipment these tests can be conducted without the disadvantages mentioned.

Another very important feature in favor of testing equipment in the shop is the fact that a splendid opportunity is afforded beginners to become familiar with car lighting equipment. Indeed it might properly be regarded as the intensive and inductive method of teaching new men a good working knowledge of such appliances in the shortest time possible.

Efficiency of Testing Equipment Demonstrated

The cause of damaged equipment such as burned out armatures, defective commutators, bent shafts, damaged switch boards, burned out contacts, etc., frequently cannot be determined on a coach in train service, but invariably may be ascertained by means of the testing apparatus. One of the early puzzling experiences with a generator tested by means of the shop equipment was an arcing commutator which acted perfectly when the generator operated as a motor but arced excessively when driven as a generator. The armature was tested for short circuits, grounds, sprung shafts, eccentric commutator, etc., by the regular ordinary methods and found free of these defects. It was finally discovered that the stiff brush leads or "pig tails" acted against the brush tension springs which lessened the pressure of the brushes on the commutator sufficiently to cause arcing. This trouble was remedied by bending down the "pig tails," thus increasing instead of diminishing the brush pressure. The cause of burned out commutators and armatures was not even suspected previous to actual demonstration while conducting tests by means of the shop equipment. The most important feature concerning efficiency of the testing equipment has been proved by the fact that repaired and tested parts when applied on equipment has always given good service and one can feel reasonably sure that parts so tested can be installed on a coach and placed into actual service without further test. Careful inspection, however, should periodically be required at terminals.

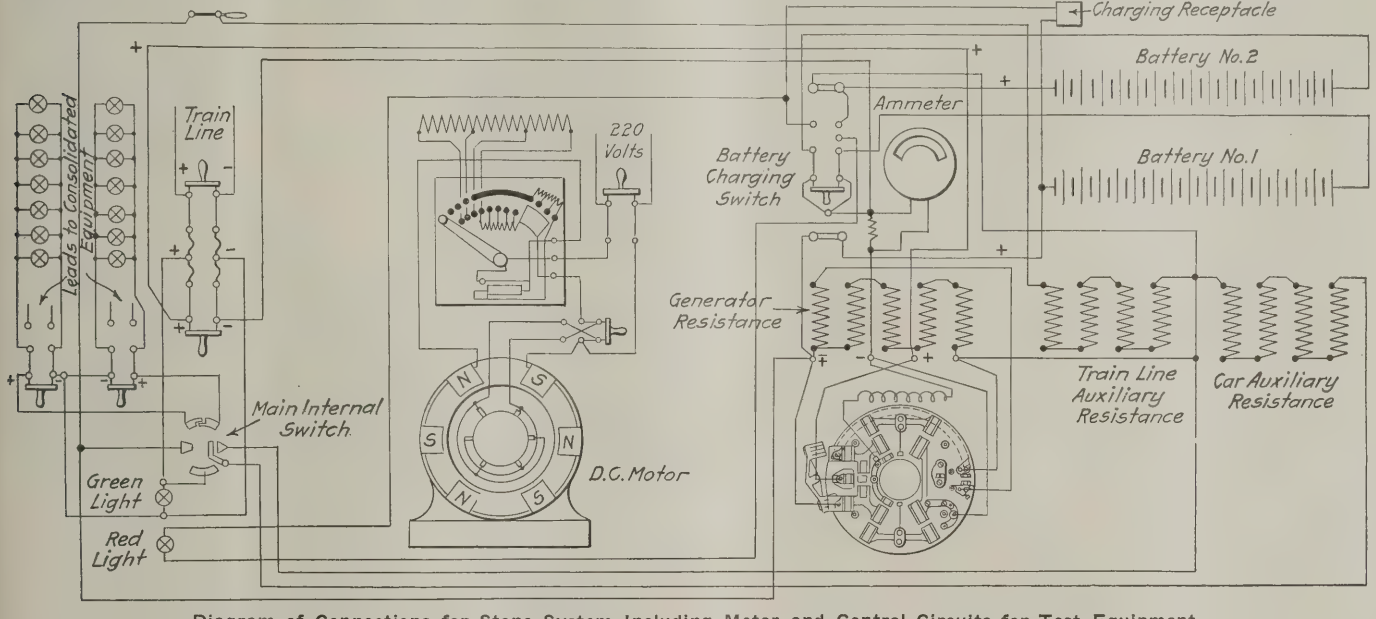


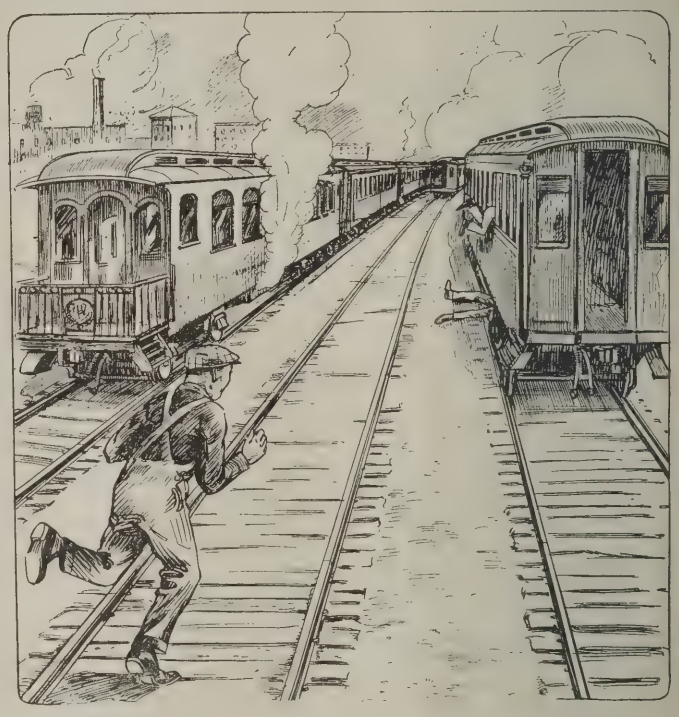
Diagram of Connections for Stone System Including Motor and Control Circuits for Test Equipment

The Trials and Troubles of a Car Lighting Man

Hinkey Dee and Jimmy Goat Acquire Fame By Fixing the Lights on the President's Car

BY Golly! When I was a little feller only four years old I can remember distinctly of me father sayin', "Now, Hinkey Dee, your startin' out in life and I want you to grow up to be a great man, but whatever you do never praise yourself or knock the other feller." I have always remembered that and know if I hadn't followed me father's advice I'd be a sap head at the bottom of the ladder, like Jimmy Goat, instead of havin' a good brain and a big head.

I'll never forget the day I saved Jimmy Goat's life. He and a feller by the name of Eddie Ram, were workin' together this day and as I passed them Jimmy Goat said, "Hello, Hinkey Dee, have you been in any more explosions lately?" I knew he was roastin' me about the day I struck a match to see inside a battery that was on charge and got all blowed up. Just then I noticed Eddie Ram laughin' at me. I turned to him and said, "Look ahere, Eddie Ram, you and Jimmy Goat think your having a lot of fun with me and your makin' a fool out of me, but you remember the old sayin' about he who laughs first has the first laugh," and sure enough about two hours later that very same day I heard a noise like a boiler explosion and looked up the track and guess what I saw? Jimmy Goat was a-flyin' through the air one way and Eddie Ram was flyin' the other. I run as fast as I could up to the car they were workin' on and there was Jimmy with his head stuck in the axle pulley of the car on the adjoinin' track with his feet sticking out of the truck and Eddie Ram had gone clean through the window of the same car and was layin' with his head stuck between the seats and his feet hangin' out of the broken car window. I grabbed Jimmy Goat by his big feet and pulled him out of the axle pulley and pulled Eddie Ram out of the window. Great Caeser's ghost! When I got a good look at them fellers they were the funniest lookin' pair I have ever seen. Jimmy's nose was bent like a race track and he had a black eye and a split lip. His clothes were torn to threads and he was some slippery lookin' guy. Eddie Ram was a dead ringer for an ex-pugilist. He had a corrugated ear, a lump on his head that was the image of a cherry and walked like a car with a flat wheel. After I had Jimmy and Eddie all gathered up the boss appeared on the scene and wanted to know what train Jimmy and Eddie had been struck by. By that time Jimmy was able to speak and the first thing he said was "Did you see my pipe anywhere's?" We hunted for Jimmy's pipe and found all but the stem. I told Jimmy he must have swallowed it but he said he didn't think so as he didn't feel sick. The boss got wise to what had happened. He looked at the car that Jimmy and Eddie had been workin' on and said, "Jimmy Goat, how did you blow those batteries up like that?" I said, "Boss, Jimmy didn't blow them batteries up, they blew him up, I know because I saw him agoin'." The boss told me to keep my trap shut. Then Jimmy explained to the boss that he and Eddie Ram were pullin' a crate of batteries out to see if the cells were dry and that Hinkey Dee played a joke on them and blew them up. Then's when I got mad. I wanted to lick Jimmy Goat, but the boss stopped me. The boss examined the car and turned suddenly to Jimmy and said "That's what did it, you poor simp,



I ran as fast as I could up to the car they were working on and there was Jimmy with his head stuck in the axle pulley of the car on the adjoining track. . . . Eddie Ram had gone clean through the window of the same car.

didn't you know that car was on charge, why you pulled that crate out of the car without pulling the car off charge or disconnecting the crate and when you lifted it, the terminals of the battery struck the top of the battery box making a spark and exploded the gas in the battery." "Why," he said, "Jimmy, I'm surprised at you, I have a little boy home six years old that would know better than that."

Well, I didn't exactly know what the boss said that Jimmy had done, but I agreed with the boss and told him that if common sense was water, Jimmy Goat wouldn't have enough to wash his teeth. Eddie Ram said he did all he could to stop the battery from blowin' up, that when they started to blow up he stood in front of them, but couldn't stop them. Jimmy Goat said he didn't care if he could only find the stem of his pipe, and that the boss was all wrong because when he went to college he studied that when dynamite blew up it went down. I kind of weakened and felt sorry for poor Jimmy so we all shook hands and made up. I told Jimmy that I had had the last laugh

as my first laugh and that we split even. But the boss said that at the rate we were blowin' up batteries he thought it would be cheaper to the company to pay us to stay home. However, he said, "I'll give you fellows one more chance and then if you don't stop blowing around here I'll have to find someone that will."

The following week the boss rushed up to me and Jimmy and said, "Hinkey Dee I want you and Jimmy Goat to meet the Red Special at Bull Run Junction. The President's car is on that train en route to the Specific Coast and has been reported with the lights in trouble." He handed us two meters to take along so I gave one to Jimmy Goat and kept one for meself. He said, "Now, Hinkey Dee, I want you and Jimmy Goat to do your best and show the President of the road that we have the right stuff in our Car Lighting Department." Jimmy told the boss he'd fix the lights or his name wasn't Jimmy Goat. I told the boss if Hinkey Dee couldn't fix it there was no use of any one else a tryin'. So we started out. I took along the meter, a monkey wrench and a crow bar. Jimmy

Jimmy missed the top step and fell on top of me and we both fell off the car.

carried a meter, hammer and chisel, bag of tobacco and his pipe. After we reached the Bull Run Junction, I turned to Jimmy and said, "Now, Jimmy, as I know more than you about car lightin' I want to give you a tip. When the car arrives don't be a poor boob and get all nervous." By Golly, but Jimmy got mad when I said that. He said, "Look-a-here, Hinkey Dee, you big fat head, don't you try to tell me what to do, I know all about car lightin' and I'm not afraid of you or the President of the road himself. I know me own business and when it comes to car lightin' I'm Jimmy Goat all over." I said, "Now, Jimmy, don't get mad you got me wrong, I didn't mean you were no good, I know you and me is better on car lightin' than anybody." Then Jimmy said, "Well then close your mouth until the train arrives."

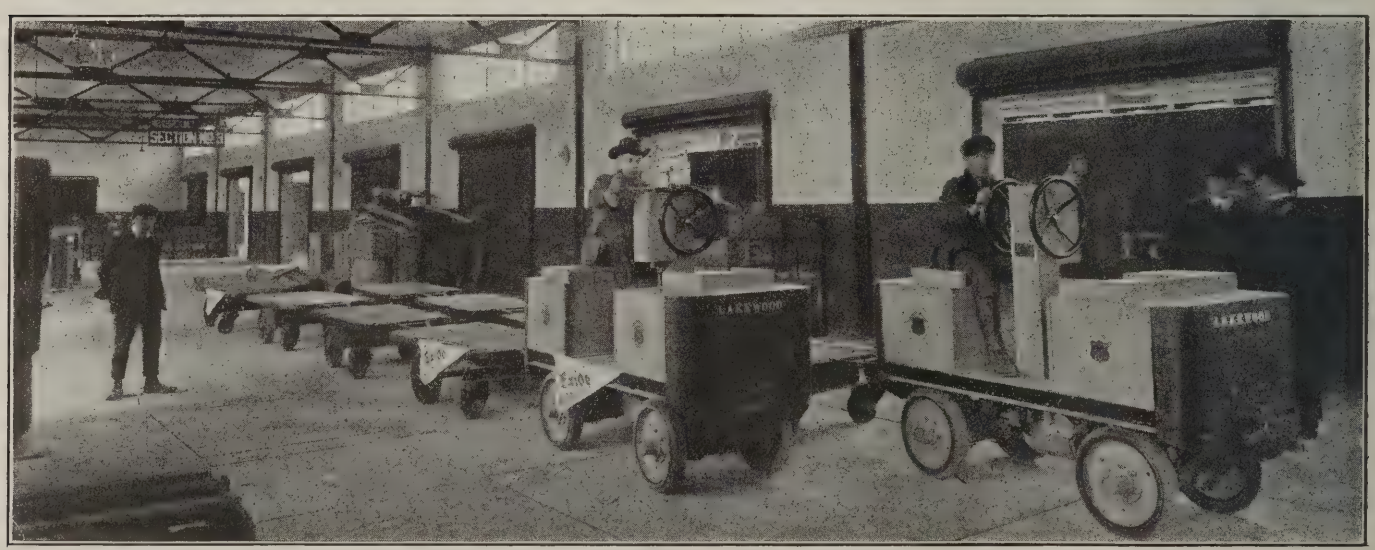
We waited a half hour and then the train whizzed in. Jimmy jumped for the observation platform before the train stopped and I jumped after him. Jimmy missed the top step and fell on top of me and we both fell off the car, but we didn't stop. I jumped on one end of the car and Jimmy jumped on the other, we run through the car as fast as we could and Jimmy nearly knocked the President down. Jimmy excused himself and told the President who he was, then we got busy. The train started and there we were, mind you, me and Jimmy Goat on the President's car. My Goodness, but I felt good! I said to meself, "Hinkey Dee your in your own class now—mind you, me riding with the President."

I missed Jimmy and went in the kitchen to see if I could find him. I found him standing at the switchboard with his hammer in one hand and chisel in the other. Just then the porter came back and said the boss wanted to know how soon we'd have light on the car. I told him to go right back and tell the President that we'd give it to him just as soon as we found it. It sure does make me mad to have people asking foolish questions when I'm busy. The train started to speed up and I noticed the little green lamp at the top of the switchboard locker started to burn. Then I wanted Jimmy to go get the President and show him the little green lamp so he'd know we were on the job and good at car lightin', but Jimmy wouldn't do it. Then Jimmy said, "Isn't this a funny lookin' voltmeter, its got voltmeter spelled wrong, its spelled a-m-m-e-t-e-r and look at the funny lookin' thing fastened to it marked s-h-u-n-t." He said, "Say Hinkey I don't know how this works do you?" "Sure I know, get out of the way and let someone use the meter that knows how." I took the old wires and the bar marked "shunt" and handed them to Jimmy. Then I connected my voltmeter leads to the meter and tested the voltage. Well you might think I'm not tellin' you right but there must have been a thousand volts because when I connected that meter across the line it jumped out of my hands, the hand on the meter flew across the scale so fast I dropped the meter. Jimmy said it was more volts than he ever saw. Smoke started to come out of the meter. I said to Jimmy, "Gee, Jimmy, we must be goin' at an awful rate of speed to have a generator voltage like that." As I went to put the meter back in the box I read on the inside of the lid, "This meter is an ammeter and not a voltmeter, do not connect this meter across the line but in series with the circuit with shunt as shown in diagram." I said, "Why Jimmy you made me burn this meter up, why this is not a voltmeter." Jimmy said, "I told you I didn't know what it was." "Why, Jimmy, do you mean to say you didn't know it wasn't a voltmeter? Well it's your fault because you handed it to me." I said, "Well, I'm goin' to fix these lights," so I walked through the car and examined all the sockets. While I was away Jimmy fell against the switchboard and his head struck

something and the lights all came up bright. I was passing the President just as the lights all come up and he said, "Good for you young man. What is your name?" I said, "My name is Hinkey Dee, the Electrical Expert." "Well," he said, "young man you're a wonder on car lightin' because I've had electricians riding this car and tryin' to fix the lights for two days and to think that you have fixed them so quickly." I told him I knew I was good on car lightin' because I had studied it from A to Z and that I wasn't all books either. He said, "What was wrong with the lights?" I said, "Why-er-why-er-why leaky lights, broken wires and the whole thing was out of gear." "Oh, I see," said the President. He said, "I'm glad you fixed us up" and he walked into the other end of the car. I went back to Jimmy he told me he fell against the switchboard and the lights come up, I said, "Why you didn't fix 'em, I fixed 'em—it was all in a socket in the car and as soon as I fixed it the lights come up." Jimmy said, "I guess your right, good for you, Hinkey we can fix 'em, can't we?" I said, "We sure can." When we got back and I told the boss maybe he wasn't pleased. He was so glad that we were so good on car lightin' that he forgot to get mad about the ammeter bein' burned up.

KANAWHA & MICHIGAN USES ELECTRIC TRACTORS AND TRAILERS

The new freight house of the Kanawha & Michigan at Charleston, W. Va., has been equipped with electric tractors and trailers for economy in the handling of package freight, both inbound and outbound, as well as to accomplish a general speeding up of freight house operations. The photograph illustrates the character of the equipment which was supplied by the Lakewood Engineering Company, Cleveland, Ohio.



Tractors and Trailers Used in the Freight House at Charleston, W. Va.

The tractors are of the four-wheel-steer, four-wheel drive type, operated by a 48-volt, 45-ampere motor (continuous rating), supplied with current by storage batteries. The motor is mounted on a longitudinal shaft with a worm drive on both axles. Among the distinctive features of the equipment is the short turning radius of 5 ft. 1 in., measured to the outside edge of the platform at the forward corner, which is of great advantage in handling the tractors and trains in close quarters. Another feature is the double-end control. The control equipment is mounted in a centrally located stand flanked at either end of the car by battery boxes, each fitted with a driver's seat. Thus the driver has the controller, steering wheel and safety pedal in convenient position before him no matter which seat he occupies. The feature is of special value in handling the tractors in narrow passageways.

In connection with the steering and drive arrangement it is of interest to note that the power is transmitted from the axles to the wheels without the use of universal joints. Instead the transmission is accomplished by a train of bevel gears, using the vertical shaft which also serves to swing the wheel in steering. Power is applied to this shaft from a bevel gear on the axle and is transmitted from the shaft to the wheel by means of a second bevel gear of large radius mounted on the inner face of the wheel.

The trailers used at Charleston are of the caster type with main wheels 16 in. by 4 in., and caster wheels 8 in. by 4 in. and a weight of 720 lb. The carrying capacity is 5,000 lb. This type is particularly adapted to installations where it is desirable to do a certain amount of hand trucking. Another Lakewood type, the four-wheel-steer trailer tracks more accurately and has the further advantage that it may be hauled in either direction. Still other types of Lakewood trailers include a balanced type having a pair of 18-in. center wheels with two casters at each end, and a "fifth wheel" type for use on rough ground in cases where considerable hand hauling is done.

STREET RAILWAY CONDITIONS in cities where approval of rate advances has been refused or deferred are to be investigated soon by a new government commission. President Wilson has cabled his sanction for creation of the commission.

A Discussion of Axle Generators and Pulleys

New York Car Lighting Club Debates on Truck-Hung versus Body-Hung Machines and Solid versus Perforated Pulleys

THE New York Car Lighting Association held its final meeting of the season on Tuesday evening, May 6, at the Grand Central Terminal, New York. The subject assigned for this occasion treated with the advantages and disadvantages of truck and body-hung generators, together with the relative merits of the solid face and perforated generator pulleys. Mr. Jack Lambert of the Pullman Company read the first paper, an abstract of which follows:

"Mr. President and gentlemen of the N. Y. C. L. A.: In getting up this paper I have made an effort to condense a broad subject and at the same time to bring out the more important facts. I have not been in a position to conduct any extensive tests, therefore, I cannot give you any specific cases or figures relative to the maintenance cost of the two types of generator suspension which I am about to describe. I have divided the subject into two parts with a view of making it clear to all.

"First, I will take up the subject of mounting the generator on the truck. This application is necessarily heavier and has many more parts to be inspected for wear or breakage, being mounted on the outside truck end sill facing the center of the car, the link and cradle type of suspension being the most common mounting. With this type of application the vertical center line of the generator and axle pulley remain vertical with any movement of the truck, thereby keeping the belt tension constant, although the belt stretches somewhat. In the truck-hung generators approximately any output may be secured even up to a marked overload except in the winter months, when due to its acting as a snow plow, the snow and ice has a tendency to stop its work as a part of the car lighting system. In this connection I may say that of late a great deal of time and study as well as expense has been applied to what we call a 2-point link suspension, this suspension being mounted on the truck as previously noted. At first it was necessary to have an offset in one of the links (commonly known as U-bars) in order to give proper belt clearance, and it is my understanding that a great deal of trouble has been experienced with broken links. In most cases it was found that the links were faulty at the offset due to defective forging at the factories. Improvements have been made by changing some of the parts to eliminate the offset in the back link. The side bars which pass through the truck end sill are normally firmly tied down and the pivot is above the side arm, the link pins being 2¼ in. in diameter with a bearing surface of approximately 5 in. The wearing part is lubricated with a heavy grease by the use of grease cups. These improvements make the truck-suspension more practical than previously and result in cutting down its maintenance and increasing its safety.

"The girder or body-hung generator is much lighter and has fewer wearing parts, making it a serviceable form of application from this standpoint. It also receives better protection from jarring and flying ballast on account of it being mounted so much higher above the running rails and being protected by body springs. It is also much more accessible. However, more care must be taken in the application of belts so as not to make them too short or too long. If the belt is too short it would probably pull apart or spring the armature shaft, or perhaps both, when the equipment is operating at the greatest distance between centers. If the belt is too long, the belt tension is far from being sufficient when the machine is operating at the shortest centers, causing the machine to be inoperative at many times, and sometimes causing the belt to jump the flange on the armature or axle pulley and become lost.

"Considering the expense of applying new belts to body or underframe equipment, which is about twice that of the truck-mounted, it becomes a subject of much thought and is probably the weakest feature in this form of application. The belt losses, however, are only one difficulty as during the winter months the slippage is excessive on this type of suspension. From tests conducted it would prove in many cases during the

bad weather in the winter that the maximum output on the 100 ampere type "C" U. S. L. girder-hung machine would only average 40 amperes.

"These tests were made on a constant inspection and notes were taken as much as possible at all stops. Thus the car on a hard run in the winter months, equipped with a girder-hung machine, would not in most cases be able to maintain good lighting. However, better results are obtained from underframe equipment. I do not know of any adequate means to make up for the excessive tension on belts when the car goes around the curve, unless, as in several cases I have known of, where this was overcome by mounting the axle pulley in the center of the axle and changing the generator to this line.

"In discussing the use of perforated or solid faced pulleys which are common to any form of mounting generators there seems to be many opinions as to which gives the better service, both having their advantages. Everyone knows that with a perforated pulley it is possible to have a much thicker face which allows many more crownings without increased weight than you would have on a solid faced pulley of the same thickness. The perforated pulley also has a tendency to give a belt cushion eliminating air pockets and slippage. It is just these perforations, however, that is the objection to these pulleys due to the cost of drilling which calls for several hours of skilled labor. Moreover, due to the perforations much of the roadbed is placed on the belt travel cutting through the belt fibers in the summertime and forming ice and snow paths in the winter

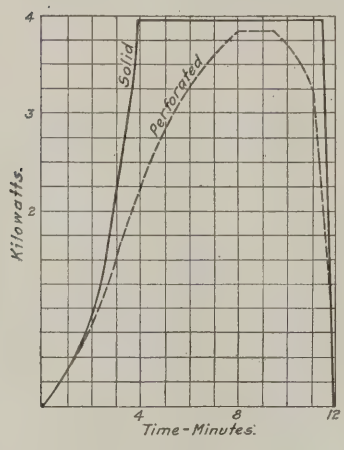


Fig. 1

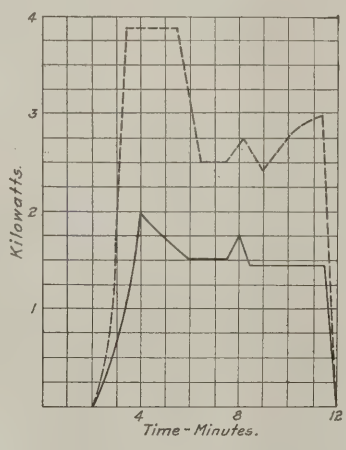


Fig. 2

Fig. 1—Plotted from Readings Taken During the First 10 Miles of Test Referred to in Mr. Weber's Paper. At This Time the Pulleys Were Slightly Rusted and the Belt Performance Very Good.

Fig. 2—Result of Second Test on Same Equipment and Over Same Piece of Track After Equipment Had Traveled 800 Miles.

time, with the resulting failure to handle a high output which it is necessary to get from our equipment in the winter months.

"These conditions are eliminated by the use of a solid faced pulley which does not allow the ice or snow to enter from the center of the pulley to the face of the pulley or belt, which, no doubt, is a point in favor of the solid pulley. By cutting a circular groove around the face of the pulley we eliminate the air pockets formed between the face of the pulleys and the belt and allow the belt to seat itself. Also in the solid faced pulley we have increased the strength at the flanges, which is quite desirable. We have had many experiences where the flange broke away from the pulley after a few crownings in a direct circular line with the perforations, causing the belts to be lost and perhaps a light failure. This brings up the point regarding the relative strength of the solid and perforated pulleys of like weight. We have never had the same difficulty with the flanges breaking away with the solid faced pulleys as we have encountered with the perforated pulleys and the first cost of the former is much less than that of the latter."

The second paper of the evening dealt with the same subject and was read by Frank Weber of the Delaware, Lackawanna & Western railroad. It is as follows:

Mr. Weber.—"This discussion is for the purpose of bringing out the different ideas of the car lighting men

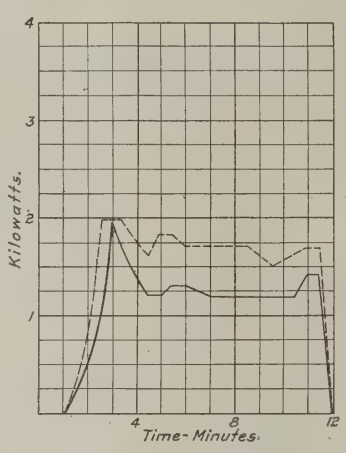


Fig. 3

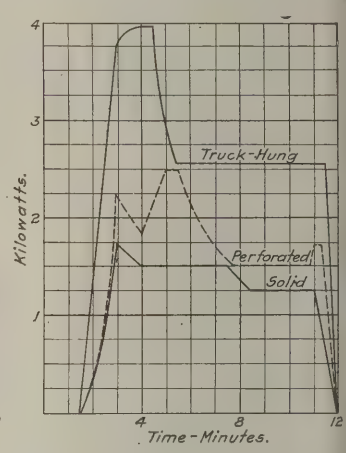


Fig. 4

Fig. 3—Result of Third Test After Equipment Had Traveled 1,600 Miles.

Fig. 4—Result of Fourth Test After Equipment Had Traveled 2,400 Miles. A Curve Showing the Performance of a Truck Hung Machine Has Been Introduced for Comparison.

to get better results for all, tending to give us longer belt life and lower maintenance cost. In reading the different editorials on car lighting the majority seem to favor body-hung generators, the advantages claimed being the ease of repairing, less suspension trouble and less truck work owing to the removal of the heavy machine from the truck and placing it on the body of the car where it does not overbalance the truck. Other advantages are simpler and cheaper suspension, and less pounding at the generator.

"We find, however, that the belt cost is more as body-hung belts are from 30 to 50 per cent longer. When a body-hung belt is lost is costs considerably more to replace it than it does to replace a truck-hung belt, and it is still an open question whether the mileage obtained on the body-mounted machine is higher than that mounted on the truck. In my experience the truck-hung mileage is the best, although the body-hung performance is better than when the machines were first installed in this way.

"The main fault that I have observed with body-hung belt performance is the poor drive under severe service conditions which is much worse in this section during the winter when snow and ice hamper the operation of the system and expose the belts to all kinds of difficulties. During the winter of 1917-1918, perhaps the severest

winter to which axle lighting has ever been subjected in this part of the country, our truck-hung machines drove much better than the body-hung. I rode a train during one of the worst storms and took a test of the output of a truck-hung and a body-hung generator and found that the truck-hung was putting out about 1,440 watts against 740 watts on the body-hung. Of course, neither was doing what it should have done but the fact remains that 1,440 watts was enough to keep the car lighted while 740 watts would not. Both machines were 3 kw. and the truck-hung had a perforated pulley while the body-hung had a solid pulley.

"Since our last meeting we have run a test to determine the relative merits of solid and perforated pulleys and the result is shown in the curves which I will show after reading this paper. In regard to this test I may say that both machines were body-hung; the same tension was maintained; the readings were taken at the same instant; both belts were new at the start of the test; and both cars were on the same train and subject to the same weather conditions during the entire test. The belts were 4-in. 5-ply rubber and of the same roll. At the end of the test each had stretched about three-quarters of an inch. No adjustments were made during the test and each belt made the same mileage. The pulleys were of the same size and type and both belts were driving from the top. The regulators were locked and each belt drove to its full capacity under these conditions. I will also submit the curves for your own inspection and you may draw your own conclusions as to the capabilities of each.

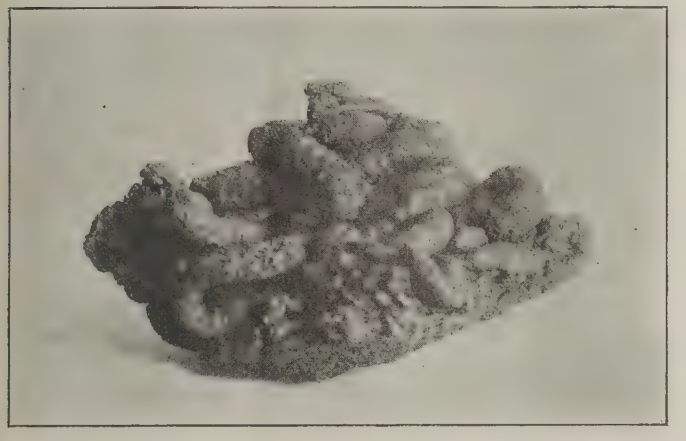


Fig. 5. A Photograph of the exhibit referred to by Mr. Meilloret. A stringy mass of rubber forced through the openings of a perforated pulley.

"Curve No. 1 shows a high output due to rough pulley surfaces and new belts. The output went over the maximum output of the machine in both cases, and it is noticeable that the solid pulley drove more than the perforated.

"Curve No. 2 shows the perforated pulley doing much better than the solid faced. The solid pulley shows the effect of slippage by the brightening of the surface to a greater degree than the perforated.

"Curve No. 3 shows a further falling off in power output with the perforated pulley still having an advantage.

"Curve No. 4 shows about the same results as curve No. 3. On this curve is shown a test of a truck-hung machine at the end of the same mileage and under the same conditions as in the case of the body-hung. A solid faced pulley was used.

"These curves are simply shown as evidence of what was obtained under good weather conditions most favorable to solid faced pulleys and body-hung machines. They are sufficient to show the needs of more investigation of the subject and a study of the drive proposition.

"The most complete breakdown of drive under winter conditions is a serious drawback to car lighting and much time and thought should be devoted to perfecting a more reliable method. Owing to the lack of time and facilities to make any accurate and extended tests we will not go deeper into the matter at present, but will invite discussion on the subject hoping to stir up interest and get some valuable suggestions."

Abstract of the Discussion

Mr. Weber.—Mr. Lambert states that the perforated pulleys pick up cinders. I believe that the solid pulleys hold cinders more than the perforated pulleys. I have here two pieces of belt, one of which was used to drive a perforated pulley and the other to drive a solid pulley, and as you can see for yourself the belt used on the solid pulley shows considerably more cinders embedded in it than the other one.

Mr. Meilloret (Long Island).—The truck-hung machine is nearer the roadbed and it will pick up more cinders. These cinders will fly through the holes in the pulley and cut the fiber of the belt. With perforated pulleys our belts get very rough. In connection with the subject of solid pulleys and perforated pulleys, I have something in the way of an exhibit which, I believe, will be of interest to you. It is really no argument in favor or against the perforated pulleys, but is simply an example of what occurred on one of our generators with the perforated pulley. On this particular generator the bearings grew hot and the heat developed by the hot bearing was transmitted to the pulley causing the rubber of the belt to be forced through the perforations into a clinging mass on the inside of the pulley. Every bit of rubber on the belt went through these perforations.

Mr. Kershaw (Penn. R. R.).—There is one thing that cinders do, and that is to wear away the crown of the pulleys. I believe it is well to turn the belt occasionally, say every 5,000 miles.

Mr. Hulse (Safety Car Heating & Lighting Co.).—Cinders will get into both kinds of pulleys. In my opinion, both truck-hung or body-hung machines may give equal characteristics under different conditions. It is very difficult to judge. One road may have one experience, another road another experience. As far as the cost of manufacturing is concerned there is practically no difference between perforated pulleys and the smooth pulleys.

Mr. Webber.—In making the tests referred to in my paper the regulators of the two machines were locked so as to allow the generators to put out five kilowatts if possible. We do not give so much consideration to the cost of operation, the output being the principal thing. On a car with a smooth faced pulley the belt will slide between 45 and 60 amperes, but with the perforated

pulleys when the current comes up to 60 amperes it stays there. Not half the tension is needed on perforated pulleys and consequently better air cushions are obtained.

Mr. Meilloret.—The amount of slipping doesn't bother us. We manage to keep up the load and that's what we want. We do have trouble with crowns being worn. We make our own pulleys and it is quite an expense to drill all the holes.

Mr. Kershaw.—Each time the pulley is recrowned we get about one year out of it, which makes the pulley last about three years. We have about 300 body-hung machines and have had very little trouble with them where there is sufficient give in the springs to prevent slipping. I think that neither the solid faced pulleys nor perforated pulleys are the best. I believe that slots cut in the pulley's face, parallel to the shaft, will do away with all slipping. However, I have had very good results by putting a piece of belt around a pulley's face. For six months we had no cinders, gravel or anything in the belt. This was the only real good belt life I have ever obtained. I think sometimes it is the best proposition to buy cheap belts with the expectation of losing them soon.

Mr. Price (B. & O.).—Snow seems to have an effect on slipping. The current comes up to a maximum and then drops again. I also agree with Mr. Lambert in the matter of breaking flanges. Pulley flanges will break off after a number of crownings.

Mr. Kershaw.—I think the best way to make a test is to take a car as it comes in from the road and in that way you will be able to find out where the trouble lies in the organization and be in a position to remedy it. It is useless to take a special pulley or a special belt and make a special test.

Mr. Leitner (Erie R. R.).—The body-hung equipment gives the belt very heavy tension and in rounding curves puts a heavy strain on the flanges which may be the reason of flanges breaking off when pulleys have been recrowned.

Mr. Kershaw.—This should not be the case if the springs are not too tight. Our springs are about 2 ft. long and of ¾-in. stuff and take care of our equipment very nicely.

Fall Meeting

I want to call attention to the next meeting of the association which will be held on the first Tuesday in September. The discussion at that time will be on the subject of batteries and I would ask that you get yourselves fully prepared to discuss this subject. We will also be glad to hear at that time of any tests that may be run between now and then with reference to belts.

The meeting stands adjourned.

The First Sleeping Cars in America—in the world—were those which were run on the Cumberland Valley between Chambersburg, Pa., and Harrisburg, in 1836 or 1837. This fact, stated for the purpose of correcting an error, is brought out in an interesting letter to the Philadelphia *Record* by M. C. Kennedy, president of the Cumberland Valley. And he calls attention to the fact that those two sleeping cars were kept in service more than ten years, or until 1848. Chambersburg and Harrisburg are only about 52 miles apart, but by running a train at night, the Cumberland Valley accommodated passengers arriving in Chambersburg by stage in the evening from the West who wished to take the early train the next morning from Harrisburg to Philadelphia. Another historical date which is frequently misstated is that of the first mail car. In connection with the recent hearing at Washington on the subject of railway mail pay, it was stated that no attempt was made to distribute letters on the cars until 1862; but the fact is that a mail car was running between Boston and Albany in 1853. W. A. Davis, the clerk who is credited with having distributed letters between Quincy and St. Joseph, in 1862, is said to have copied the idea from England, by way of Canada, and it may be that the English post office sorted letters on the cars before 1853.

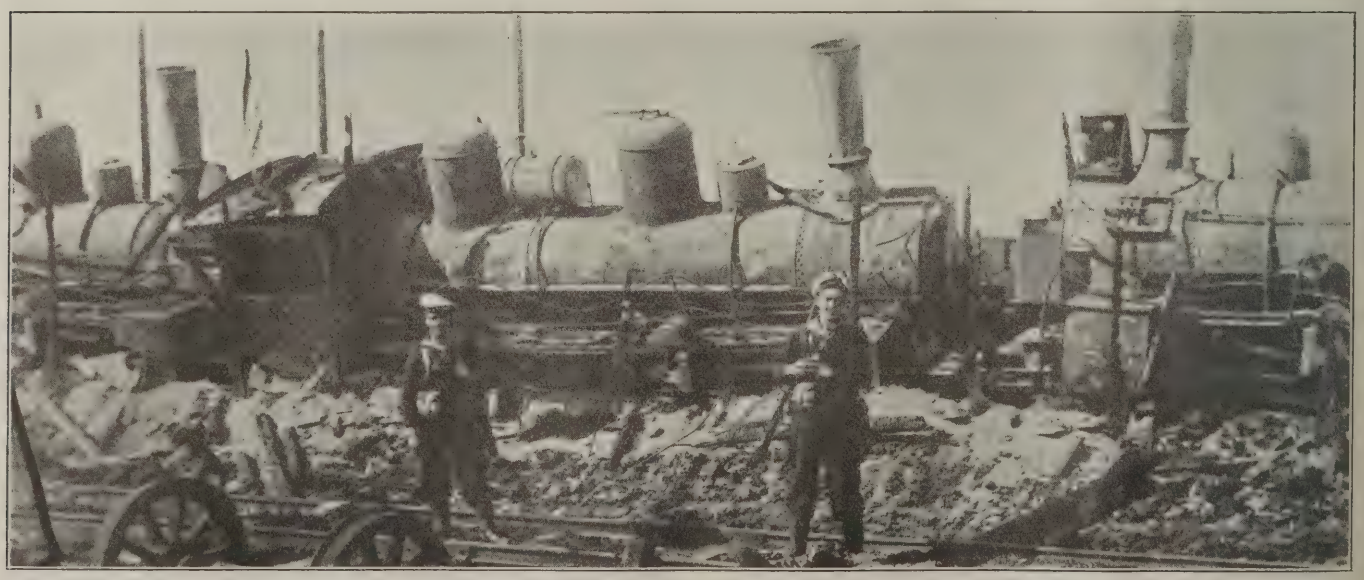


Photo from Central News

Locomotives Damaged by the Bolsheviks at Soroka in Northern Russia

Important Factors for Efficient Arc Welding*

Proper Installation Secures Flexibility—Accessories and Subject of Eye and Body Protection

By E. Wanamaker and H. R. Pennington

THERE are two distinct methods for distributing power to arc welding equipments. These may be classified as follows: (1) the standard or existing power circuit may be used to furnish power to the individual equipments, which may be stationary or portable as conditions demand. If stationary they should be installed in the same manner as an ordinary motor. If portable all receptacles should be located at various points from which the motors of the welding machines are to receive their power. (2) A separate circuit may

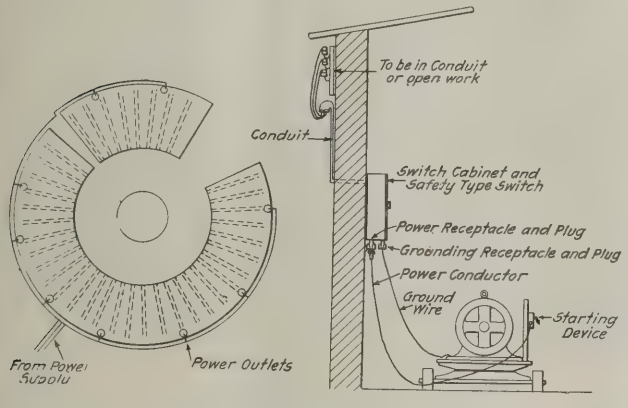


Fig. 1—Layout for Portable Arc Welding Equipment in Roundhouses

be installed to furnish power at the proper value from a motor generator set or other means operated from the main power circuit. This separate or secondary circuit is usually designed to furnish power at 60-volts to a number of control panels located at different points within the area to be served.

The principal difference between the two systems, as far as distribution of power is concerned, is the cost of installation. The individual operator equipments as a rule are the self regulating type using no resistance in series with the arc to waste the power, which is not the case with the latter mentioned system of distribution, wherein at least 50 per cent of the total power used is consumed by a rheostat. Therefore, in this method of distribution the circuits would be required to carry double the power needed for the self regulated equipment, in addition to the increased carrying capacity necessary to compensate for the difference in potential of the two systems; the former using 250 or 440-volts, the latter approximately 60-volts for distribution. The field for the lower voltage system is therefore limited to installations where the cost of power is not so important, where the waste of power in rheostats may be lost sight of, where the average load factor is sufficient to utilize the capacity of the machine, and where a number of operators are working reasonably close together so that but little copper is required for welding circuits; otherwise the low voltage which is used with this system requires an excessive copper capacity to carry the comparatively high current when it is necessary to distribute the power over a large area.

Stationary and Portable Welding Equipment

There are conditions where the welding equipment must be brought to the work if full economy of arc welding is to be secured. On the other hand there are conditions where the opposite is true or again it may be necessary to meet both conditions. Generally in manufacturing plants, a very large per cent of the work can be brought to the welding means, but in some industries such as ship yards, roundhouses, car yards, etc., it would be false economy to move the massive work to the welding machines, for instance, to move a dead locomotive, car or other heavy structural work the cost would be excessive and the job difficult. At the present time the indications are that a system of both stationary and portable welding equipment, operated from electrical power, will be required for railroad shops, repair yards, roundhouses and similar layouts. For classes of work more or less isolated from a source of electric power, as for instance track work, the welding equipment may be driven by a gas engine. If arc welding is to be used over an entire railroad system, the power supply should be standardized in so far as is possible in order that the equipment, (especially the portable type) may be transferred from one terminal to another when conditions demand.

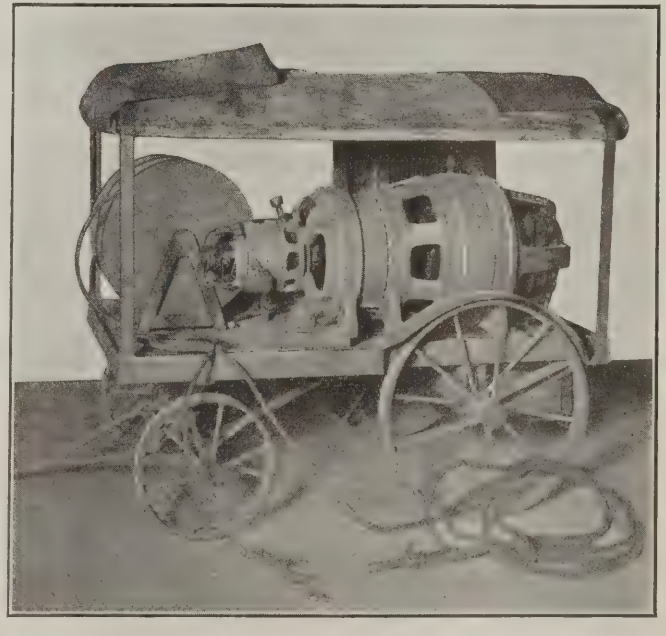


Fig. 2—A Portable Type of Arc Welding Equipment

*E. Wanamaker, electrical engineer of Rock Island Lines. H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. This article is the fourth of a series on Electric Welding. Copyrighted, 1919, by the Railway Electrical Engineer.

Wiring and Installation—Typical Layouts

The wiring around railroad terminals, especially roundhouses presents a difficult problem mainly on account of the gases, and the cost of maintenance will be governed largely by the manner in which the original installation is made. In arranging an installation it is important to keep in mind the safety features, for instance, where portable equipments are used it is necessary for the outlets and switches to be of the approved safety type and in order to provide ordinary protection from grounds, provisions should be made for grounding the frame of the equipment when in operation. Experience has proved that car yards, roundhouses, and other similar places require a portable type of equipment for the reason that a small amount of welding is done and is carried on at most any haphazard location within a comparatively large area.

A roundhouse installation for portable equipments which has been found very satisfactory over a period of more than two years, is shown in Fig. 1. Power outlets are located every 100 ft. around the house. With this spacing the extension wires used from the welder to the operator's electrode holder will never be greater than 150 ft. and ordinarily 75 ft. will be sufficient. For

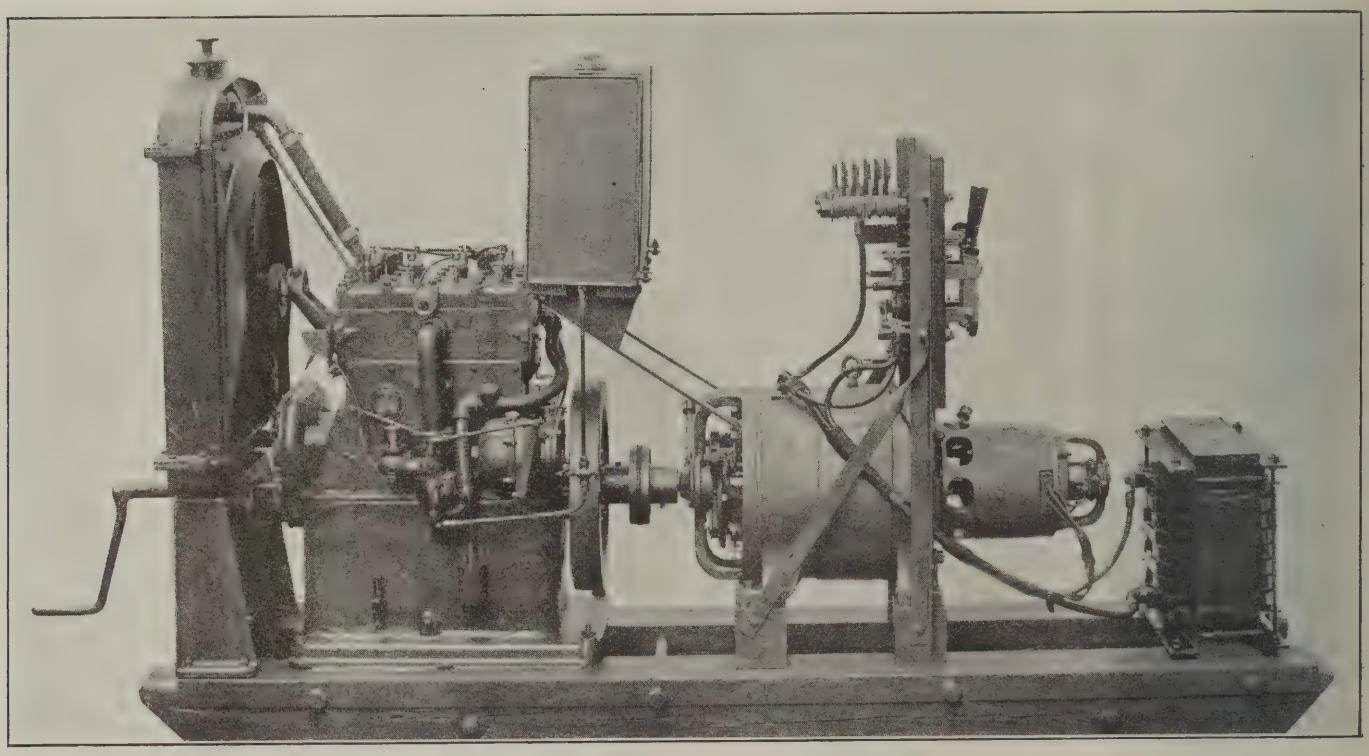


Fig. 3—A Gas Engine Driven Equipment

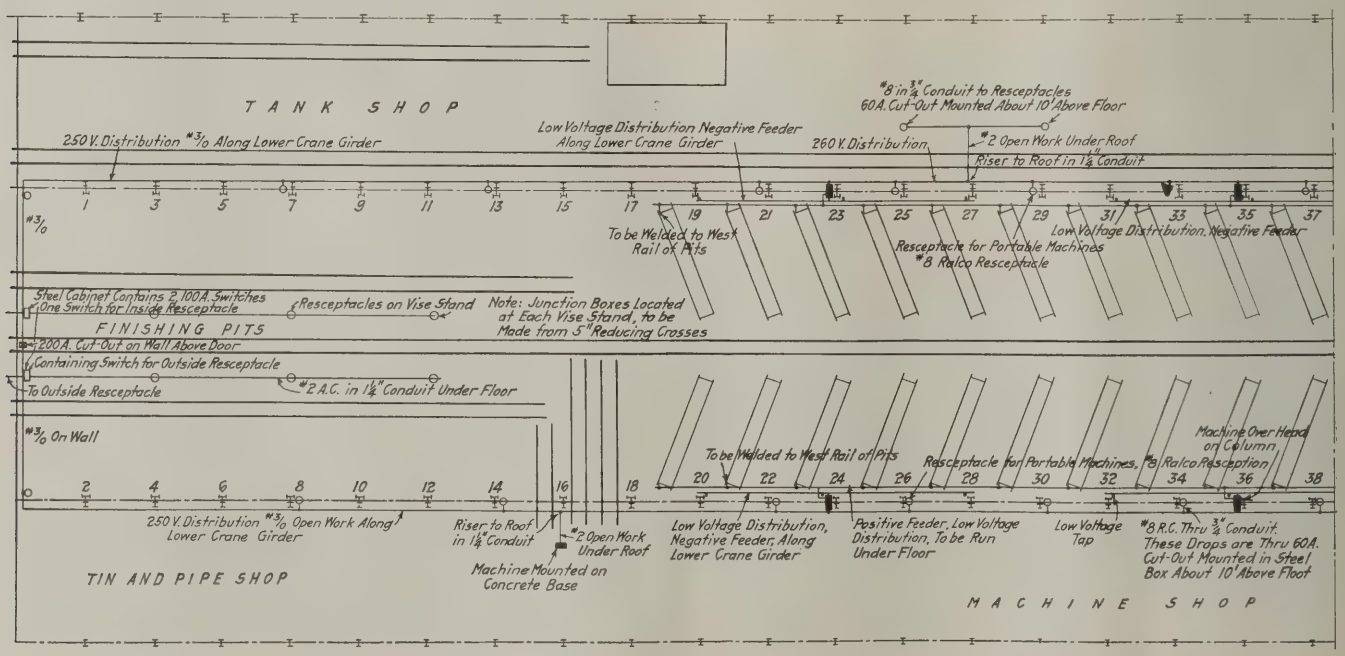

TANK SHOP
250 V. Distribution #3/0 Along Lower Crane Girder
Low Voltage Distribution Negative Feeder Along Lower Crane Girder
#8 in 3/4" Conduit to Receptacles
60 A. Cut-Out Mounted About 10' Above Floor
260 V. Distribution
#2 Open Work Under Roof
Riser to Roof in 1 1/4" Conduit
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37
#3/0
To be Welded to West Rail of Pits
Low Voltage Distribution, Negative Feeder
Receptacle for Portable Machines
#8 Ralco Receptacle
Steel Cabinet Contains 2 100 A. Switches
One Switch for Inside Receptacle
Containing Switch for Outside Receptacle
Receptacles on Vise Stand
Note: Junction Boxes Located at Each Vise Stand, to be Made from 5" Reducing Crosses
FINISHING PITS
200 A. Cut-Out on Wall Above Door
To Outside Receptacle
#2 A.C. in 1 1/4" Conduit Under Floor
#3/0 On Wall
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38
To be Welded to West Rail of Pits
Receptacle for Portable Machines, #8 Ralco Reception
Machine Over Head on Column
250 V. Distribution #3/0 Open Work Along Lower Crane Girder
Riser to Roof in 1 1/4" Conduit
#2 Open Work Under Roof
Machine Mounted on Concrete Base
Low Voltage Distribution, Negative Feeder, Along Lower Crane Girder
Positive Feeder, Low Voltage Distribution, To be Run Under Floor
Low Voltage Tap
#8 R.C. Thru 3/4" Conduit. These Drops are Thru 60 A. Cut-Out Mounted in Steel Box About 10' Above Floor
TIN AND PIPE SHOP
MACHINE SHOP

Fig. 4—Machine Shop Floor Plan Showing Circuit Layout and Location of Equipment for Arc Welding Installation

metallic arc welding cable size No. 1 B & S is large enough to carry the current this distance safely without excessive drop in voltage. The twin or triple conductor cable used between motor starting switch and power out-

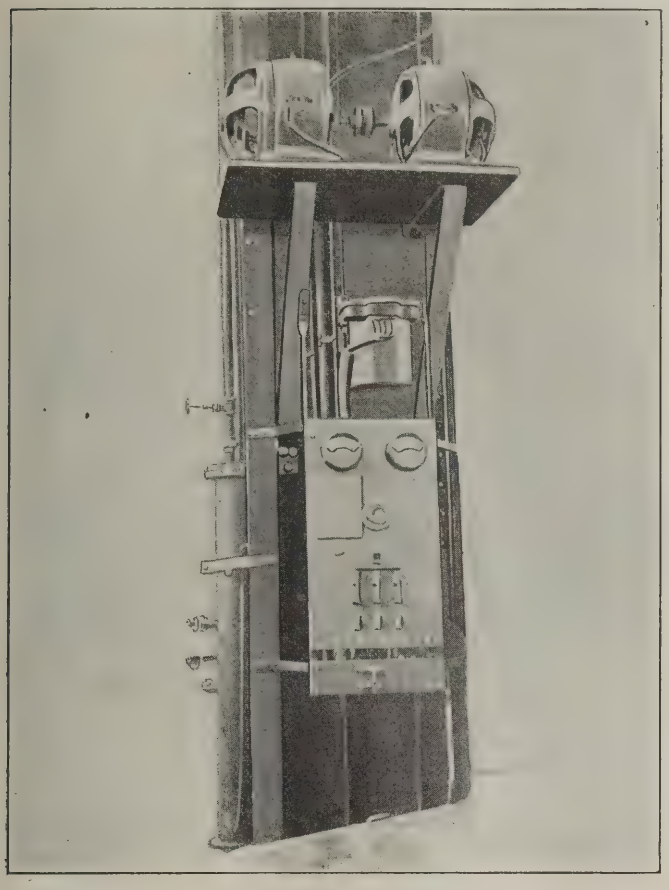


Fig. 5—Single Operator Stationary Type Welder Mounted on a Column

let should not be more than 8 ft. long, the object being to compel the operator to set the machine close to the outlet, preventing the power supply cables from laying across the aisle, where they would in time have the insulation damaged which might result in some one being injured. A second plug or an auxiliary contact to the power plug, serves to ground the frame of the motor generator set. When an operator connects a portable welding machine, he first makes sure that the safety type switch is in the open position and then inserts the grounding receptacle; the power plug is inserted next after which the safety switch is closed. The machine may then be started by means of the motor starting box mounted on the truck. Where the power supply is a.c. an oil switch, equipped with overload relays is used for starting the motor. In disconnecting the machine from

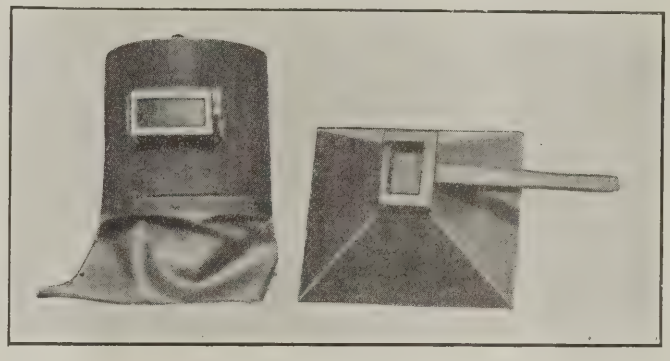
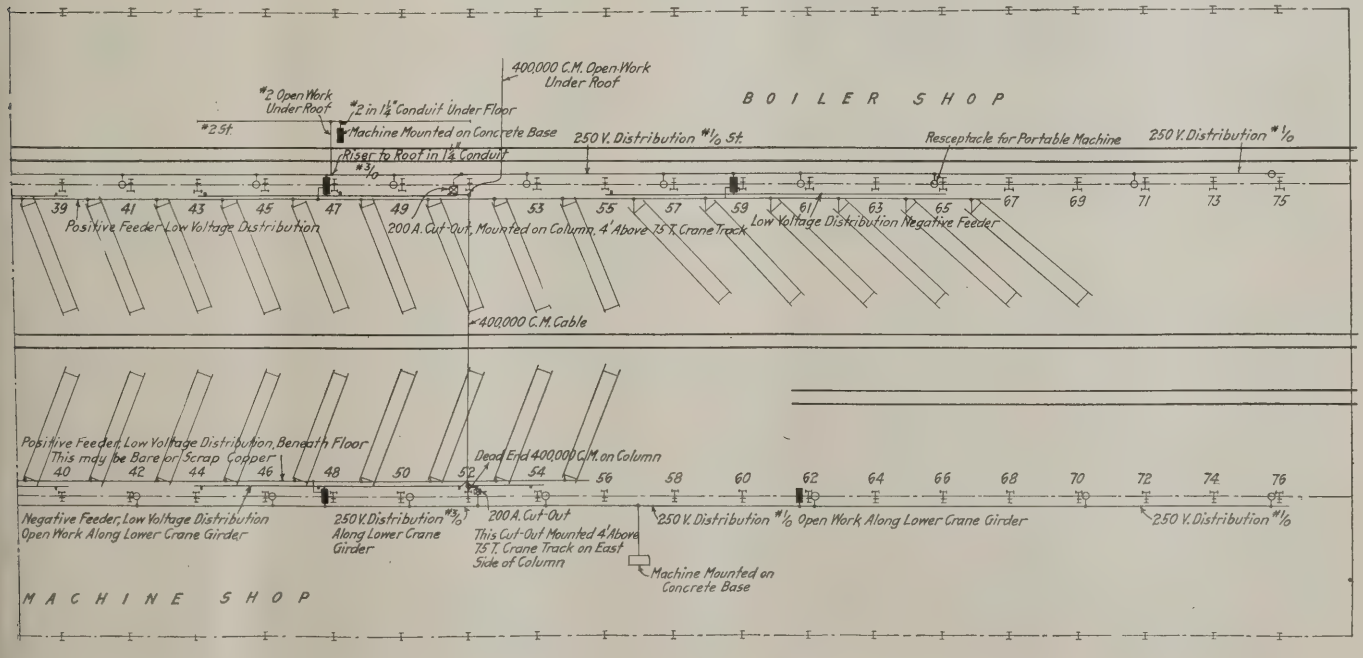


Fig. 6—Helmet and Hand Shields

the power circuit, the motor starting switch is opened, then the safety switch, next the power plug is removed and finally the grounding receptacle is disconnected. A safety switch receptacle and grounding device combined, is now on the market. It is so designed that the circuit arrangement is automatically taken care of when the plug is inserted.

A portable type of arc welding equipment for use in a roundhouse is shown in Fig. 2. This equipment is made weatherproof, which provides protection against the steam and water which usually prevails in roundhouses. The same feature also makes it safe for opera-


400,000 C.M. Open Work Under Roof
#2 Open Work Under Roof
#2 in 1¼" Conduit Under Floor
#2 St.
Machine Mounted on Concrete Base
Riser to Roof in 1¼" Conduit
#3/0
250 V. Distribution #1/0 St.
BOILER SHOP
Resceptacle for Portable Machine
250 V. Distribution #1/0
39 41 43 45 47 49 53 55 57 59 61 63 65 67 69 71 73 75
Positive Feeder Low Voltage Distribution
200 A. Cut-Out, Mounted on Column, 4' Above 75 T. Crane Track
Low Voltage Distribution Negative Feeder
400,000 C.M. Cable
Positive Feeder, Low Voltage Distribution, Beneath Floor
This may be Bare for Scrap Copper
Dead End 400,000 C.M. on Column
40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76
Negative Feeder, Low Voltage Distribution
Open Work Along Lower Crane Girder
250 V. Distribution #3/0
Along Lower Crane Girder
200 A. Cut-Out
This Cut-Out Mounted 4' Above 75 T. Crane Track on East Side of Column
250 V. Distribution #1/0 Open Work Along Lower Crane Girder
250 V. Distribution #1/0
Machine Mounted on Concrete Base
MACHINE SHOP

Continuation of Fig. 4 Showing the Eastern End of the Shop

tion outside, such as in car yards, where in case it is left out over night it may be subjected to storms. A reel is mounted on the truck on which the secondary extension cables are wound. Collector rings at each end serve as the connections between the wire cables on the reel and the positive and negative terminals of the welder. The reel provides a means for the handling of the wire cables and offers much to their protection. This method of roundhouse power distribution for arc welding is extremely flexible; its cost is nominal, and by anticipating the future capacity requirements, when the original installations are made for a cost comparatively small, additional equipments may later be used without additional installation expense.

A freight car repair yard demands practically the same layout as a roundhouse. As a rule it will not be necessary to wire the entire yard for there is usually a certain zone, within which all the welding may be done. Also, there will be a certain class of work that can be done best at a certain station—such station, however, does not necessarily demand a stationary equipment, as it can be served by a portable type which can be used elsewhere when necessary. When the conditions are such that electric power is not available or, when a very small amount of electric welding is required within an area so large as to make it almost impractical to wire it, even if electric power is available, a gas engine driven equipment such as shown in Fig. 3, may be used. A self-propelling car which provides power for arc welding is now being developed for track use. With this car it will be possible to build up worn

Fig. 7—Operator Equipped With Helmet, Apron, Gauntlet Gloves and Heavy Closely Woven Shirt

spots in track, repair bridges and track accessories, in a terminal or on a division of a railroad.

The requirements for railroad shops, foundries, ship yards, reclamation stations, etc., will be governed largely by the local conditions. For instance, in railroad locomotive shops and other similar places, it is not only necessary to be able to do welding at most any location within the shop, but at times the work shifts so as to require a number of operators to be working comparatively close together. To meet a condition of this kind and at the same time utilize the equipments to the best advantage, an installation of both stationary and portable equipments, seem superior to any other method, especially when floor space is limited, which is usually the case.

A layout for an arc welding system installed in a large railroad shop in the latter part of 1916, which is representative of many other similar locomotive and passenger car shops is shown by Fig. 4. In this shop the main distribution circuit, which is 250-volts, is run from the power house 500 ft. away, through the shop. From this circuit are operated twenty single operator equipments, eleven of which are stationary and nine are portable. In the pit section of this shop, eight

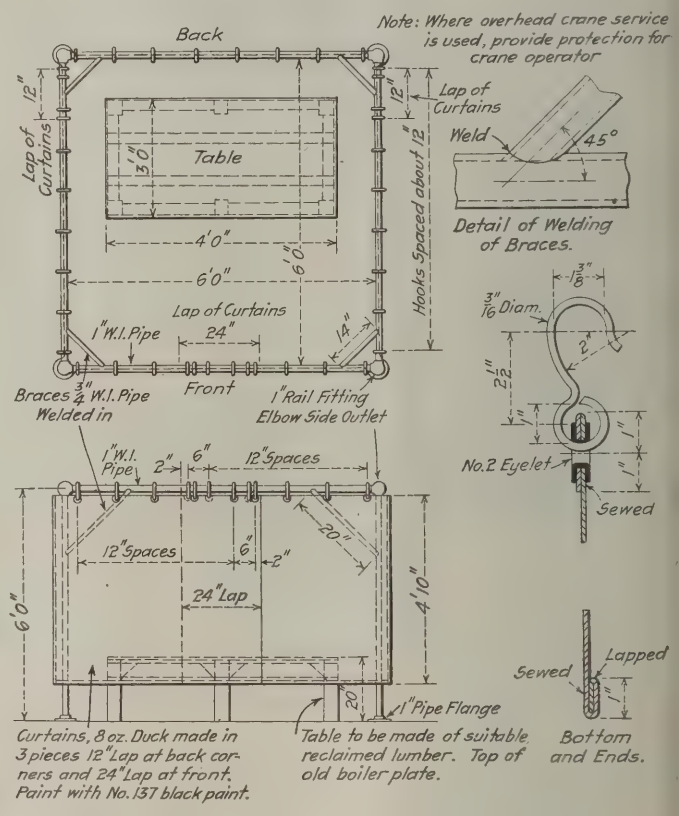


Fig. 8—Booth for Welding Small Miscellaneous Parts

single operator equipments are mounted overhead on brackets attached to the columns, in the same manner as an ordinary motor is installed. The control panels for each machine are mounted on the same column, which supports the machine platform, low enough to be within reach of the operator as shown in Fig. 5. Three other stationary single operator equipments are included in this shop, two are used for the welding of miscellaneous locomotive machinery parts, and the other is being used for miscellaneous tank and boiler work. In addition to the eleven stationary equipments there are nine portable machines in use, making a total of 20 equipments. In the reclamation, forge shop and roundhouse, there are seven other equipments of the individual operator type in use, making a grand total of 27 operator capacity for this terminal.

Referring to Fig. 4 it will be noted that the rails of all the pits are bonded together to form one side of the low voltage welding circuit for all stationary equipments mounted on columns. The other wire of the low voltage circuit is extended from each epuipment to points convenient to serve at least six pits. Provisions are made for connecting to this wire an extension cable

(to which the operator's electrode holder is attached) at four different points so as to serve the six pits. If the work within any one section covered by the stationary equipments, requires more than one arc, the additional arcs are provided with the portable equipments which may be plugged into the power outlets located between every other pit. If within a limited area there is not sufficient work to insure a fair average number of welding hours per day for an equipment then that particular section can best be served with a portable welder, which can also be used at any other point in the shop, in this way utilizing the equipment to the best advantage.

In reclamation or similar shops, where miscellaneous welding is done, the equipments can be stationary, and if a number of operators are employed continuously, a

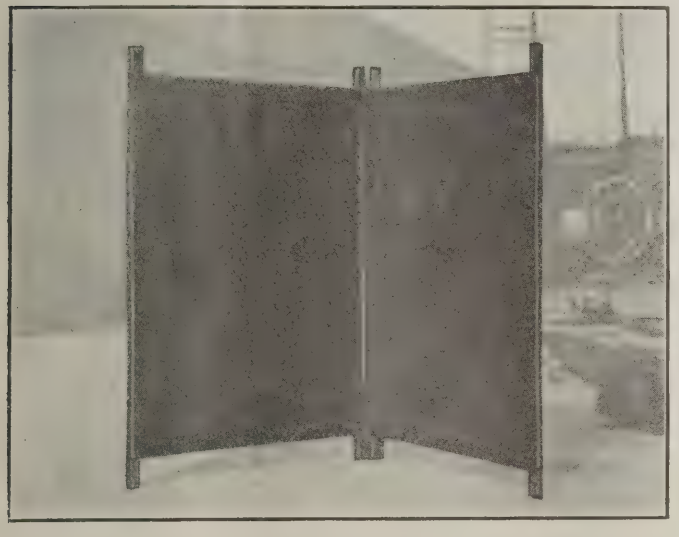


Fig. 9—A Portable Screen

multiple operator equipment may prove economical. Since the first cost of a multiple operator equipment will always be less than the same capacity in single operator equipments, and where there is comparatively little wiring required, and the cost of power is not excessive, their use may show economy over the individual operator equipments. In concluding the subject of the installation of arc welding equipments, it might be well to emphasize that there are a number of factors which govern such installations to a greater or less degree. To what extent these factors become important depends largely on the local conditions. However, in general, it is safe to say that the use of standard power circuits for the main distribution, together with single operator equipments (which may be portable or stationary, as conditions demand) will prove more satisfactory than any other method as the efficiency of an arc welding installation will be determined largely by its flexibility and also by the workwiseness and electrical efficiency of the welder which the individual equipment provides.

Arc Welding Accessories—Eye and Skin Protection

The glare emitted by an electric arc is exceedingly intense; so in order to observe the arc used for welding purposes and to protect the eyes and skin from the harmful effects, shields are provided with special glasses, the preparation of which has required considerable research work by eminent engineers, scientists and surgeons who have defined fairly well what should or should not be used. Only persons thoroughly familiar with the subject should be allowed to pass on glasses to be used for arc welding. For the purpose here desired it is sufficient to say that glasses used for arc welding, tone down the erratic glare of the visible rays sufficiently to permit the work to be seen reasonably clear and also exclude the invisible infra-red rays and the ultra-violet rays. Furthermore, glasses of the proper color tints, besides softening the glare also bring out the details more clearly. Some colors or color combinations amplify this to a greater degree than others. This can be determined by comparing different colored glasses made for the purpose. Amber or amber tinted with some other color such as green are the most common colors in general use. The infra-red rays (sometimes called heat rays) even though they are invisible can be detected by the heat, which is generated when such rays are subjected to a material that is non-transparent. To guard against their harmful effects, a glass must be used which possesses the property of absorbing or reflecting heat.

An arc produced from an iron electrode is rich with ultra-violet rays; these are very dangerous to the eyes, but it is not a difficult matter to eliminate their effect since ordinary clear glass (not quartz) will in a measure furnish the necessary protection, except that such glass does not have the qualities for eliminating the intense glare present in an arc. For that reason glasses of the proper color must be provided. There are a number of special safety glasses on the market which meet the requirements to a varying degree of success. A type

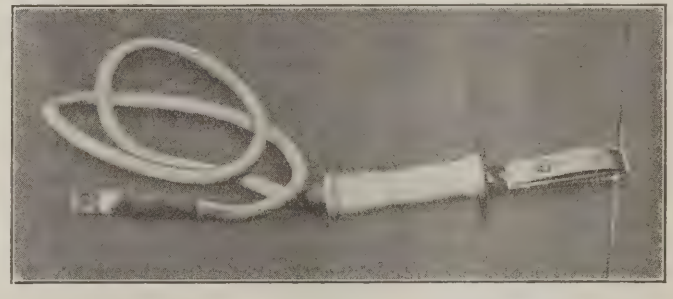


Fig. 10—A Metallic Electrode Arc Welding Holder

which is considered as being the most favorable is known as the "Noviweld," made by the Corning Glass Company, Corning, N. Y. The glass used possesses the properties of toning down the glare, excluding the infra-red and ultra-violet rays besides permitting a sufficient degree of visibility. Its color resembles that of dark mica. Efforts have been made, from time to time, to utilize mica for eye protection, but, its ununiform quality prohibits its use. Objects viewed through it appear blurred. Because of the cost of the "Noviweld" glass its use is limited in many localities, so that glasses or combinations of colored glasses, which give results approaching those of the "Noviweld" are more extensively used. A combination of glasses that have been found satisfactory for arc welding and which are used to a considerable extent consist of: one emerald green (or rich bright green); one or two ruby (or deep red) and one ordinary clear, one or both of the colored glasses

must be of the heat absorbing or reflecting kind. The clear glass is used only for protecting the colored glasses from the flying particles of hot metal.

Experience has shown that the depth of the color tint required for one operator is not satisfactory for another. However, the depth of the color tint varies in the commercial glasses, so that advantage is taken of that fact to enable each operator to select glasses having a color tint more favorable for their eyes. In choosing glasses, however, care should be exercised in selecting a color tint as deep as possible, and yet have clear visibility. Only glasses that are uniform in color should be used. If streaks or spots are present the glasses should be discarded; such defects may cause eye strain. The glasses referred to here, have been in use under the observation of the writers for over a period of five years and from service test, they are known to provide proper protection when they are selected wisely and used. There are other special safety glasses and combinations of glasses that are used, of which no mention has been made.

Helmets and Hand Shields

If the skin is exposed to the rays of a welding arc, it may be blistered by the heat. On this account the shield, which holds the glasses must be large enough to cover the entire face. Fig. 6, shows two shields which have been found satisfactory. The holder for the glasses in the helmet type is hinged so that the door may be opened to enable the operator to see the electrode better

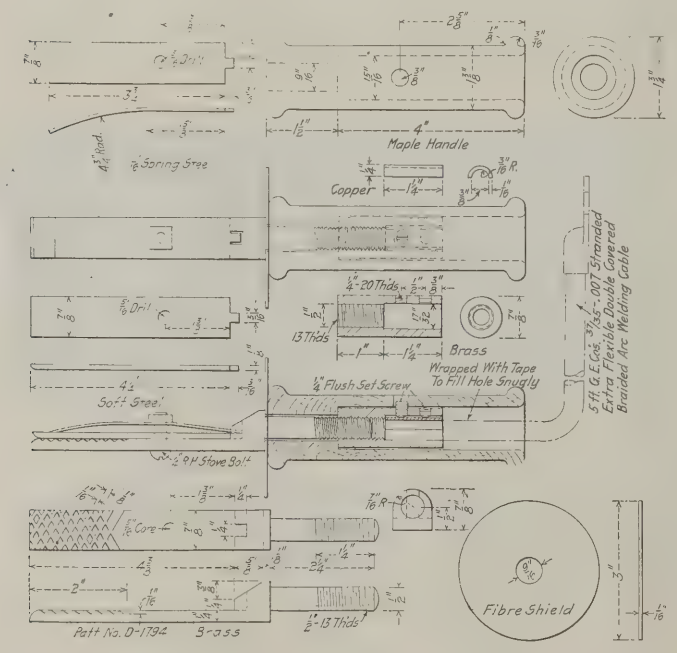


Fig. 11—Details of Metallic Electrode Arc Welding Holder

when it is necessary to change it or to observe the work more closely. Fig. 7 shows this particular feature. The leather apron attached to the bottom of the helmet serves to protect the neck from any harmful effects due to the arc. When the hand shield is used it should be held close to the face in order to prevent reflected light from entering from the back in such a way as to permit it being reflected again from the glass to the eyes. The helmet type shield is used for that class of welding where both hands are required, such as carbon arc welding or metallic arc welding, inside a firebox where it is often necessary to use one hand to steady the body. The hand shield is used in connection with light work, such as bench welding, etc. The glasses used for such work are 2 in. by 4⅛ in. and each are of single strength thickness. The dimensions should be uniform in order that the glasses will fit properly in the holder. For protection of the hands and arms from the arc's rays, it is necessary to wear gloves. Canvas gloves, preferably the gauntlet design, will serve the purpose. Ordinary work shirts made of heavy closely woven material, will give ample protection for the arms.

The subject of eye and skin protection from the welding arc is a very important factor in the arc welding

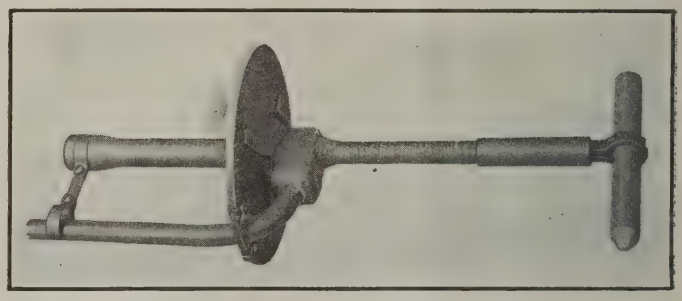


Fig. 12—An Electrode Holder for Carbon Arc Welding

process. Workmen unfamiliar with arc welding often hesitate to become operators because they know of some one who unfortunately has had his eyes severely burned by not having exercised the proper precaution, which may or may not have been his own fault. Such cases as these are often difficult to eliminate from the minds of prospective operators. They can only be eliminated by impressing upon the mind of the new beginner that it is absolutely necessary to use safety devices such as herein described, which if used properly will provide ample protection for the eyes and body from the harmful effects of a welding arc.

Booths and Portable Screens

The light rays which shoot out in every direction from a welding arc give an illuminating effect similar to that produced by lightning so that when two or more operators are working close together, or when other workmen are working nearby, each operator must be totally or partially surrounded with screens, in order that this light will not interfere with other work, also to prevent those who are unfamiliar with the process and its effects from looking at the arc, which as explained above would burn the eyes if observed for a time from a short distance away. The stations or booths for miscellaneous work consist of a table having a metal top surrounded with curtains such as shown in Fig. 8. For the class of work that cannot be brought into the booth, portable screens such as shown in Fig. 9 are required. All screens should be painted black in order that they will not reflect the light rays from the welding arc. When arc welding is a new feature in a shop the protective apparatus just described will be required to a greater degree than will be the case after the shopmen become accustomed to the process; at which time shields of every description such as pieces of sheet metal, boards, etc., will be used to protect workmen in the near vicinity from the direct rays.

Electrode Holders

The object of an electrode holder is to hold the electrode firmly so as to permit easy manipulation by the operator and to provide a means for the flow of current from the welder terminal to the electrode without excessive heating of the holder, which may be caused by poor contact between the electrode and the holder. Inferior work or a waste of welding wire is usually the result of overheating at the point of contact between electrode and holder in metallic arc welding. If the welding wire becomes red hot between the end being melted and the holder the metal will not flow uniformly. In order to assist the operator in manipulating the welding arc the cable from the holder must be extremely flexible for approximately five feet. The remaining portion of the cable only needs to be sufficiently flexible to permit easy handling. A holder of a well known type for metallic arc welding, which has been designed to permit frequent cleaning by the removal of one stove bolt, and which is provided with five feet of extra flexible cable is shown in Fig. 10, details of which is shown in

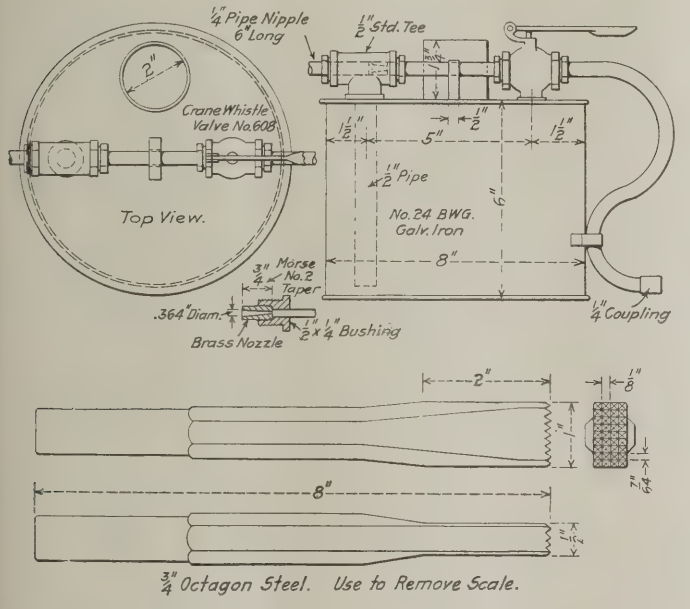


Fig. 13—Small Sand Blast and Roughing Tool

Fig. 11. This holder is simple, inexpensive and light. It has been in use for sometime; it gives good results and meets the approval of a large majority of the operators who use it. To apply a new electrode in this holder before removing the short stub it is only necessary to insert the new electrode between the jaws, then by prying the jaws further apart by means of the new electrode, used as a lever, the stub will fall out and the new electrode will be held firmly in place by the pressure of the steel spring, the tension of which is adjusted by the stove bolt. Changing electrodes in this way consumes the least possible amount of time. Fig. 12 shows a type of carbon holder used in carbon arc welding. An operator manipulating a carbon arc is subjected to a degree of heat, which is much greater than that developed from the metallic arc. Holders for the carbon arc must therefore be larger in order to carry the heavy current and to provide a greater distance between the operator's hand and the arc. It is also necessary to furnish additional protection to his hand by equipping the holder with a large heat resisting disc as shown in the illustration.

Cleaning Devices

The surfaces of the work on which welding is to be done must be perfectly clean, and free from scale, rust or oxide. It is not always an easy matter to prepare the work as described, but in order to assist in the process of cleaning various devices are being used. For the removal of light loose scale, dirt and oxides, a steel wire brush is sufficient. The heavier scale and oxides such as mill scale, blue oxide produced by an oxyacetylene cutting torch, etc., require a sand blast or roughing tool to remove them. A small light sand blast as shown in Fig. 13 is preferable, as it can be taken into small openings and used in close places. A useful roughing tool for loosening scale which may be used either in connection with air or hand hammers is shown in the same illustration.

THREE YEARS BEFORE THE ELECTRIFICATION of the London & Southwestern Railroad's suburban lines 25,000,000 passengers were carried. Due to the inadequacy of the steam service rendered this number fell off to 23,000,000 just preceding electrification. In 1916 electric service was gradually brought into operation and the number of passengers carried increased to 29,000,000. In 1917 this number further increased to 33,000,000 and in 1918 the total was 40,000,000.

A TUNNEL OF THE METROPOLITAN RAILWAY, in London, which much of the time is filled with smoke or steam, has been equipped for its 2,200 ft. of length with an iron tube for giving notice of the approach of trains, the tube to be agitated so as to produce a noise, by means of treadles, and being so arranged that it can be put out of service when no men are at work in the tunnel. It was found that horns or gongs could be heard not over 700 ft. in a clear atmosphere and a much shorter distance when the atmosphere was filled with smoke or steam. A galvanized iron tube, of about ¾ in. internal diameter, is slung along the side of the tunnel at the height of a man's ear. Hammers, to strike on this tube, are fixed, one at the middle of the tunnel and one on either side of it, each about two-thirds of the distance to the mouth, so that the distance which the sound must be conveyed is about 367 ft. from each hammer. The hammers are actuated by electromagnets enclosed in waterproof iron boxes, and the electrical energy is supplied by six two-volt storage cells; twelve volts, 60 ampere hours. The depression of a bar, at the entrance of the tunnel, opens an electric contact, and this causes the hammers to produce the desired sound in the tube; not very loud, but easily recognized. When the track bar is in its normal position no sound is made. The vibration of the tube may be felt, so that even a deaf man could avail himself of the warning by putting his hand on the tube. Any defect in the electrical circuit causes the warning to sound. As the train passes out of the tunnel it depresses a second bar, which energizes a relay and opens a contact, silencing the hammers. The apparatus has received the approval of the Board of Trade. It is patented, and is made by the McKenzie, Holland & Westinghouse Power Signal Co., London.

Care of Locomotive Electric Headlights

Rules, Regulations and System of Records Adopted for the Maintenance of the Big Four's Equipment

ALTHOUGH a year still remains before the time limit set by the Interstate Commerce Commission is reached when all locomotives must be equipped with high power headlights, the majority of roads have already made many installations. The order compelling the adoption of this equipment does not state specifically that these shall be electric lights, but inasmuch as no other means offer as many advantages as does the electric system it has been universally adopted. In order to secure the advantages which are inherent with the electric headlight installation, the same careful attention must be given to the matter of maintenance as would be required by any other electric generator, in fact it will probably develop that these electrical headlight equipments will require more care than would be needed by any stationary generating equipment for the reason that they are subjected to excessive vibration on the locomotive.

Early recognition of the importance of the maintenance problems is indicated by the following rules and regulations that have been adopted by the Cleveland, Cincinnati, Chicago and St. Louis railroad:

Rules Governing the Maintenance and Repair of Locomotive Electric Headlights, Turbines and Accessories in Round Houses

1.—The following will be known as maintenance points for Electric Headlights:

EASTERN DISTRICT:		
Linndale	Springfield	Sharonville
Bellefontaine	Columbus	
CENTRAL DISTRICT:		
Shelby Street	Moorefield	Riverside
Brightwood	Urbana	S. Anderson
WESTERN DISTRICT:		
Mattoon	Mt. Carmel	Lyons

At these maintenance points, all work required to keep the headlight and its accessories in operating condition will be in charge of such forces as will be designated by roundhouse foreman to be extended in the manner hereafter provided.

2.—Electric equipment on locomotives will be maintained to the standards fixed by this department. No additions to, or alterations in equipment as installed according to standard practice will be made.

3.—All repairs and inspections will be handled in the manner prescribed for all other parts of the engine, as regards the use of work report book, work slip, and methods of handling repairs and inspections hereafter provided.

4.—Every engine before leaving a terminal will be given inspection and operating test under steam, unless otherwise provided on authority of roundhouse foreman, and by such member of the force as he may so designate.

5.—Inspection card will be carried in each engine, on which record must be made as provided by inspection card at time of any adjustments or detail inspection of the turbine other than that provided by the running terminal test as provided in Rule No. 4. Inspection cards when completed will be forwarded to the office of master mechanic, being replaced by new card.

6.—Voltage readings will be taken on all headlight equipments at least once a month, unless such readings become necessary at more frequent intervals as made necessary by repairs or adjustment to the turbine subsequent to repairs on the engine.

7.—In taking volt-meter readings, same should be done under full boiler pressure, and adjustments made accordingly. At full boiler pressure the voltage readings must not be in excess of 32 volts with all lights on. With headlight off and dimmer off the voltage shall not rise higher thain 34 volts nor under 30 volts.

8.—Adjustments in voltage shall be made, preferably by adjustment of nut No. 639, care being taken to screw nut No. 639 in place after adjustment is made by means of tightening lock nut No. 640, taking care previously to free lock nut No. 639 by movement of nut No. 640, (screwing lock nut No. 639 in will raise speed, increasing voltage and backing this nut out will lower speed, decreasing voltage). Numbers referred to above are those covered on blueprint X-79965A.

9.—Other adjustments necessary to obtain efficient performance of turbine will be covered by special instructions from district electrical supervisors.

10.—Lubrication of headlight turbines will be accomplished through the grease cups provided—Part No. 620—by using Greoil, Grade BB. Grease cups should be filled at least once in 10 days and cap screwed down, one turn given every two days. Exception may be made to this adjustment of grease cup cap in case of engines operating the majority of their time on daylight runs.

11.—All adjustments not otherwise specified covering the maintenance, repair and operation of headlights will be left to the discretion of the men in charge of the work and to the supervision directly of the district electrical supervisors.

12.—No general overhauling of headlight turbo-generators will be made in roundhouses, all such inspections and overhauling being taken care of at the general shopping of the engine, unless necessary to do so on account of unusual performance of the turbine indicating the existence of trouble not easily located at detail inspection of the machine.

13.—There shall be attached to the turbine a tag specifying the last date of general overhauling and inspection, the same as obtains with air pumps.

14.—Turbo-generators on engines placed in storage will be protected by enclosing in weatherproof box; all incandescent bulbs being placed in store room.

List of Repair Parts to Be Considered Available Stock on Hand at All Times at Points Known as Maintenance Points as Previously Enumerated, on Basis of 20 Engines or More

Quantity	Part No.	Name of Part
1.— 2	602	Main Ball Bearing
2	603	End Ball Bearing
5	609	Cap Screws
1	614	Shaft
1	616	Turbine Wheel
3	620	Grease Cups
5	621	Deflectors (turbine end)
5	622	" (gen. ")
12	625	Brushes
2	626	Brush Holders Complete
3	629	Brush Holder Springs
2	634	End Bearing Lock Nut
2	637	Governor Complete
5	647	Lever Pins
5	657	Ball Housings Comp.
1	659	Box Assorted Screws
1	666	Armature Complete
1 set of 2 coils	667	Field Coil (right)
	668	" " (left)
3	685	Valve Complete
5	1063	Slide Contact
5	1079	Terminal Contact
1 box containing 50 small brass cotter keys		
1		Knife Switch
1		Dimmer Resistance
1 Headlight Case Complete with Interior		

2.—In addition to the above there will be carried at Shelby Street, Bellefontaine and Mattoon, and also Mt. Carmel, one headlight turbo-generator complete. This turbo-generator must not be used excepting as an emergency unit, in case of the removal of the generator in service on account of extensive damage not possible of repair by virtue of repair parts carried in stock.

3.—All lights used for replacement and maintenance of headlights will be those covered on standard list of electric incandescent bulbs. Round bulbs will be considered the standard shape.

4.—All defective parts removed from electric headlight equipments will be billed to Beech Grove for repairs, regardless of their condition.

5.—No condulets, fittings, or piping will be carried in stock other than that provided in our standard stock, and any demands for this must be anticipated by requisition.

6.—Any special material not covered on the above, but specified on standard drawings will be furnished on requisition approved by the district electrical supervisor.

7.—To take care of emergency use of road engines in hill and other pusher service—for engines not permanently assigned to this service, an extra headlight house complete will be furnished equipped with portable cord and plug attachment, and twin socket arrangement to enable connection to the deck light and to maintain the deck light, will be provided at Bellefontaine and Sharonville.

THE FOLLOWING TOOLS WILL BE CONSIDERED AS STANDARD FOR POINTS KNOWN AS HEADLIGHT MAINTENANCE POINTS.

Volt Meter Gasoline Torch Magneto 3 Special Wrenches

Instructions Governing the Operation and Care of Electric Headlights by Engine Crews

1.—It will be the duty of engine crews to report immediately upon arrival at terminal, in the usual manner followed in reporting repairs to the engine, any irregularities in the performance of the electric equipment, either as to brilliancy of illumination, failure of lights, poor focusing, or irregular performance of the turbine.

2.—Engine crews will at no time add to or alter any of the equipment as installed on the engine.

3.—Engine crews will make no adjustments except those as pertain to focusing of the headlight, which will be considered within their duties to adjust to suit their personal demands, and the reconnecting of any broken wires which may be detected while the engine is in their care.

4.—The lubrication of the headlight turbine and parts will be taken care of entirely by the roundhouse forces; no lubricant should be supplied or adjustments in lubrication by the engine crew, except in the case of branch runs where the engine is in charge of engine crew and not accessible to the maintainers assigned to this work, on which runs engine crews will screw down grease cup caps. These grease cup caps should at no time be turned down more than one turn every two days.

5.—In case of breakage of headlight globe, it shall be removed and replaced by a globe removed from any cab lamp.

6.—In case of complete failure of the turbine use hand lantern as substitute for headlights, hanging lantern on outside of headlight case.

7.—In case of headlight generator failure on engine carrying signals, marker lamps will be opened, bulb removed, top cap of marker lamp opened and fitting removed and wrapped securely around hand rail—oil lamp shall be lighted and lamp closed.

8.—In case it is necessary to extinguish marker lamps, marker lamp will be opened and small key on socket pushed upward, on marker lamps equipped with key sockets. For marker lamps not equipped with sockets, bulbs shall be backed out of socket and laid in bottom of classification lamp.

9.—No particular care need be exercised in opening throttle to turbo-generator. Run with throttle full wide open as long as the use of turbo-generator requires it, but in case lamps reach an unusual brilliancy, throttle the steam at hand valve until about the usual brilliancy of lamps is secured.

10.—When standing on siding or passing other trains, or wherever required by law to reduce the brilliancy of headlight, dimmer switch will be used to throw the dimmer on the headlight, except in the case of switch engines which are not equipped with dimmers, but in place of which are equipped with incandescent bulb of less brilliancy.

11.—No part of these rules is to be interpreted as conflicting with Transportation Department Book of Rules.

Methods of Keeping Records

The locomotive headlight inspection card, which is shown in Fig. 1, is kept in a case located in the cab. These cards are 6 in. by 9 in. and contain 31 spaces, a space for each day of the month for which period the card remains in the locomotive. At the end of the month the filled card is turned over to the master mechanic, who takes such action as is warranted by the information shown upon it.

Examination of a filled card shows the dates the locomotive headlight equipment was inspected; the

UNITED SATES RAILROAD ADMINISTRATION
DIRECTOR, GENERAL OF RAILROADS
CLEVELAND. CINCINNATI CHICAGO & ST. LOUIS R. R.

INSPECTION OF LOCOMOTIVE HEADLIGHTS

Engine No._____ From Month of_____
To " "_____
Kind of Equipment_____

Date	Terminal	Volts Headlight		Grease cups Filled	Lamps renewed			Signature
		On	Off		15W	250W	100W	

Last Greasing on previous card(Date)_____
Completed cards to be filed with Master Mechanic
Report detail work done on MP Form 347

Fig. 1. Locomotive Headlight Inspection Card which is Kept in a Case in the Cab.

terminal where the inspection was done; the voltage of the generator with the headlights turned on and off; lubrication; lamp renewals and the names of the inspectors.

There are a number of advantages derived from the use of an inspection card of this type. The filled out cards are kept on file in the master mechanic's office. If at any time information is desired on the condition of the headlight equipment on a particular engine reference is readily accessible. Should headlight failure occur due to neglect on the part of the maintainer

the responsibility is easily placed. Dates of lubrication are shown on the card and provide a simple means of indicating to the maintainer the period of greasing. Lamp consumption is shown in the three columns under "Lamps renewed."

Form NYCL MP 347 Adopted 8-16 O P 1mil 12 15 18 6670

LOCOMOTIVE WORK CARD. No._____

Eng. No.	Eng'r.....or Insp.....	Place and Date

Work Performed by | Date

REMARKS—Why Not Done	Foreman	Date

Fig. 2 Front and Reverse Side of the Locomotive Work Card.

UNITED STATES RAILROAD ADMINISTRATION
DIRECTOR GENERAL OF RAILROADS
CLEVELAND, CINCINNATI, CHICAGO & ST LOUIS R. R.

HEADLIGHTS

Inspected, Adjusted or Repaired

At_____

Date_____

Engine No.	Condition of Equipment or Work Done

(Send to District Electrical Supervisors Daily)

(Signed)

Fig 3. The Supervisors Daily Form. This sheet is filled out by the electrician and forwarded to the electrical supervisor.

In addition to the locomotive headlight inspection card, two other forms are used. These are the locomotive work card, shown in Fig. 2, and the supervisor's daily form, shown in Fig. 3. Both of these forms are supplied by the enginehouse foreman. The engineman or inspector may report on the work card some defect or failure in the headlight equipment. This is handed to the enginehouse foreman, who assigns it to the electrician for repairs and attention. The working card shows on one side who performs the work, and on the reverse side provision is made to indicate why the work was not done, if such is the case. The working cards are filled out by the electrician regardless of whether the work was reported on the card by another party or was found by him in the pursuit of his regular duties. After the work has been performed the working card is signed by the electrician and dropped into a box for the enginehouse foreman.

The third form shown in Fig. 3, with the heading "Headlights," is printed upon paper of letter size. This sheet, when filled out by the electrician, is forwarded to the electrical supervisor and gives him an idea of what is being done at the terminals in his district. If nothing is found defective, O. K. is marked after the engine number.

The electrical supervisor compares these sheets from the various terminals and checks the information, thereby keeping in touch with the movement of the equipment from one terminal to another.

The Broadway Limited express of the Pennsylvania Railroad, running between New York and Chicago, 906 miles, in 20 hours, was restored on May 25. This train was discontinued on December 1, 1917, to relieve the congestion of traffic and to facilitate prompt movement of troops and government supplies.

If You Have Been Obsessed by the Fear that William will not get what is coming to him forget it. Lloyd George, in a speech delivered recently, said William would be prosecuted. That settles it; he will be.

If America had alone had William to deal with he would at this moment be in very grave peril. But before arrangements could be made to burn him at the stake a strong demand for executive clemency would sweep the country and his sentence would be commuted to imprisonment for life. Two months after his incarceration he would be released on parole. A collection would be taken for his benefit and a fund of five or six hundred thousand dollars would be raised and turned over to him. Six months after his release on parole he would receive a full pardon and the rights of citizenship would be restored to him. A bill would be introduced in Congress granting him a pension of $10,000 a year in partial reparation for the indignities heaped upon him. In the second session of Congress following its introduction the bill would pass both houses and become a law. In five years from the date of the signing of the armistice William would be a popular hero, the Governor of some Western state, and a formidable candidate for the Presidency.—*The Topeka Capital.*

Electrification Facts and Factors

Construction Details of Contact Shoes Used on Over-running and Under-running Third Rails

By A. J. Manson*

ONE of the fundamental points of difference in electric locomotives is the method employed in the collection of the electric current. They can be classified under two headings, namely: Those equipped with pantagraph trolleys to collect the current at high voltages from overhead wires located several feet above and directly over the track; and those equipped with third rail shoes to collect the current from conductors located alongside of and adjacent to the running rails.

In the past two issues we have considered the pantagraph collector and have traced the circuit up to

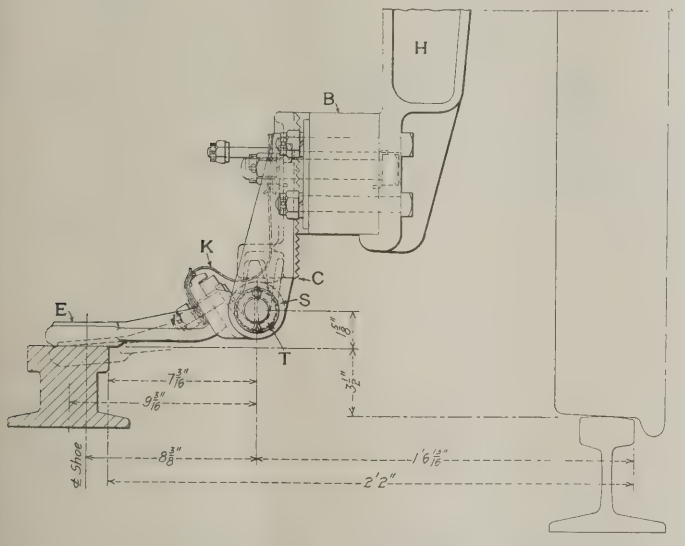


Fig. 1—One View of the Overrunning Shoe

and including the high tension circuit breaker. We will now consider the third rail shoe mechanism and the main power circuits for the collection of the direct current from the third rail.

There are two types of third rails, the over-running and the under-running. The location of the contact surfaces in respect to the running rails is nearly the same in the two types. For example, in the case of the over-running third rail, the centre of the contact surface is located approximately 27¾ in. from the gage line of the running rail and 3½ in. above the top, while in the case of the under-running third rail it is 28¼ in. from the gage line and 2¾ in. above the top. Sectional views of the two types of construction, with dimensions, were shown in the *Railway Electrical Engineer* for March.

In general the construction of the third rail shoe mechanism is the same for either type. There may be conditions which will affect the design somewhat. For instance, the New Haven passenger locomotives operate a greater part of the time on alternating current, the current being collected from an overhead wire by means of a pantagraph. It is very essential that the third rail shoes, used to collect current when the locomotive is operating over the New York Central tracks, be raised out of the way to avoid breaking off, when operating on the alternating current.

Before going into the details of this construction we will take a simpler shoe, which is fixed in position. The type of shoe as used on the Pennsylvania locomotives operating into the New York Terminal is shown by Fig. 1 and Fig. 2. Two hangers *H* are bolted to the truck frame. These hangers are provided to carry the shoe-beam *B* which is made of an insulating material, usually of wood. The insulating material is necessary, due to the fact that when the third rail shoes are in contact with the third rail, all metal parts connected with them are "alive" and the voltage must be kept away from any part of the locomotive that is grounded. Sufficient distance on the beam must be given between the hanger and the "live parts," so that the electric current will not creep along the shoe beam even when exposed to dirt, moisture or snow. It is important, however, to keep the shoe beam clean and properly painted with an insulating paint so as to increase the factor of safety and to prevent any chance of this creepage. It might be well to explain in a few words as to what we mean by "creepage." Voltage as we know is analogous to pressure and the distance which the electric current will jump through the air varies with the voltage. The distance, however, is extremely short with 600 volts, as it is only a small fraction of an inch for 11,800 volts; something like ¼ in. While the distance the

*Westinghouse Electric and Manufacturing Company, New York.

current will jump with 600 volts in the air is very small, still the creepage distance may be much greater and depends on the condition of the surface over which the current creeps. Take, for instance, the third rail beam condition: If this beam is charred and wet, and covered with dust and dirt, the voltage may actually cause the current to "creep" several inches along the surface of the beam to ground, thereby causing a short circuit. No creepage would exist if the beam was smooth, painted and clean.

On the beam *B* is mounted the bracket *C*. This bracket is adjustable so that the shoes can be set by gage to a certain height. The adjustment is made by loosening the bolts *D*, Fig. 2, of which there are three or brackets mounted on extended ties, and is located in reference to the running rails, still there are irregularities in the third rail which must be followed by the shoes. To aid in this, the springs *S* are used. These springs are slipped over the shaft *T* around which the shoe swings. It will be noted that the shoes are levelled or rounded on either side. This is done to eliminate any sharp corners which might catch on the third rail, resulting in the shoes being broken off. It is essential that the shoes be kept to gage, otherwise considerable trouble will be experienced due to broken shoes. The shoes are made weaker than the other parts of the apparatus, so that they will easily break if any object is struck by them and a severe strain

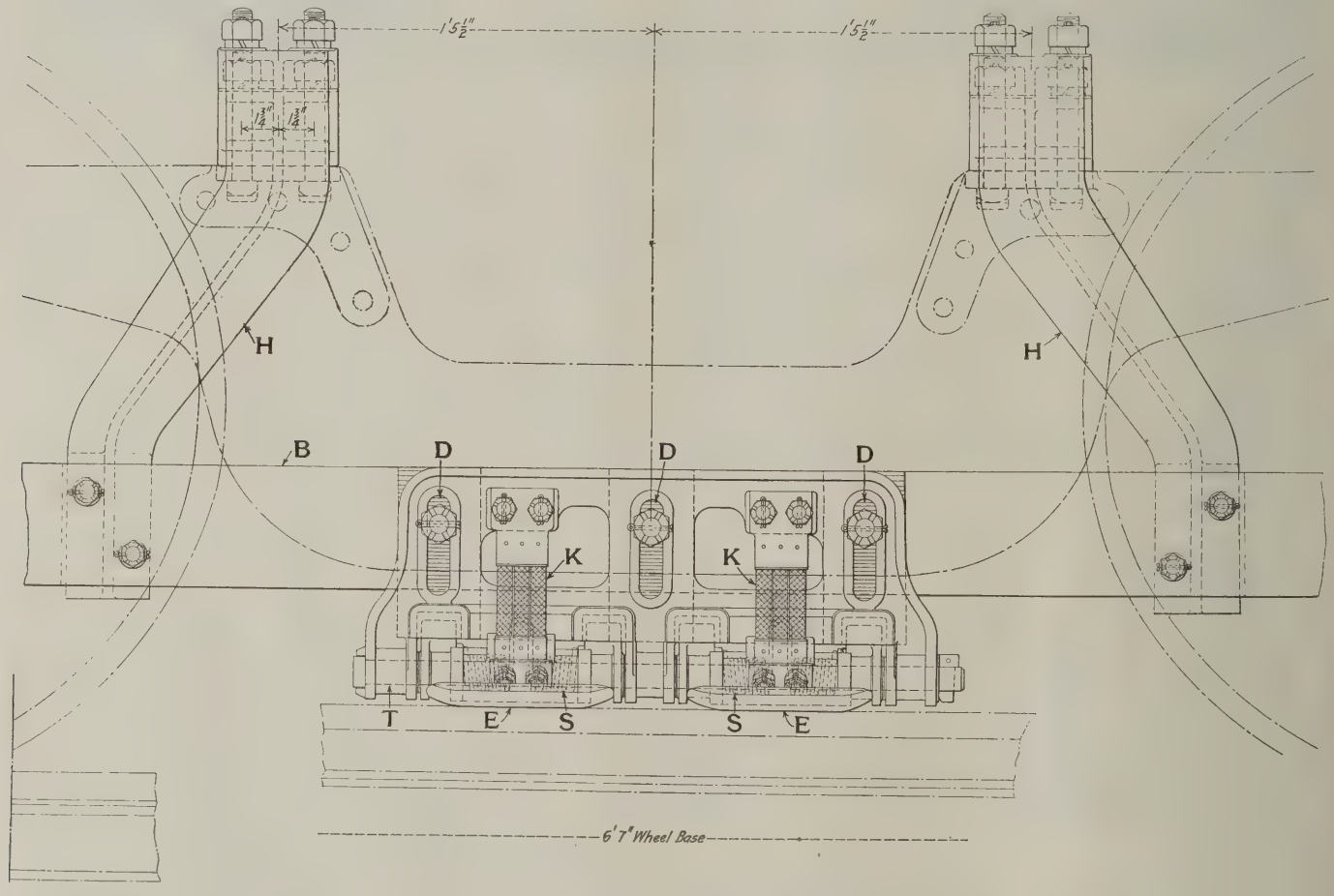


Fig. 2—Side View of the Overrunning Shoe Showing Method of Supporting It

and slipping, either up or down, one or more teeth, as is found necessary. The location of the third rail bears a fixed relation to the running rails or track so that the gage for checking up the shoes is a simple one. It is made from a board, reinforced with iron where necessary to prevent wear and sets on the running rails with an extension which passes under the shoe. Referring to Fig. 1 there is shown a dotted position of the shoe *E* which is one inch below the normal position. This dotted position shows the lowest allowable position and must not be more than 1 in. below the horizontal or operating position; neither must it be less than ¾ in. These dimensions give the location of the shoe to which it must be set, using the gage.

While the third rail is carried on either insulators will not be thrown upon the bracket and the shoe beam.

As in the case of the pantograph trolley, braided copper shunts *K* carry the current around the joints and bearings. The shunts are very much larger, due to the fact that the current taken by the shoes, is very much greater than in the 11,000 volt operation. The high voltage is 18 to 20 times greater than the third rail voltage so that for the same horsepower it is necessary to collect 18 to 20 times the current from the third rail. The lower end of the shunt is bolted directly to the shoe casting, and the other end is bolted to a part of the bracket which forms the terminal for the shoe lead or cable.

The under-running third rail shoe would be practically of the same construction except that the normal

position when off the rail would be higher than the contact surface, to provide for sufficient pressure against the third rail.

An interesting third rail shoe construction is that used on the New Haven locomotives and multiple unit cars which operate over the third rail construction on the New York Central. As previously mentioned the mechanism is so arranged that the shoe can be raised when not running on the third rail system, so as to be within the N. Y., N. H. & H. R. R. clearance line. In addition to this feature the shoe also can be lowered away from the third rail approximately 5 in. This is an "emergency" feature, and provides a means of disconnecting the electric power entirely from the locomotive in case of a short circuit which would not be disrupted by the blowing of the fuses. On a large electrified system such as the New York Central's where heavy drafts of power are taken by each locomotive, and where the current delivered to the third

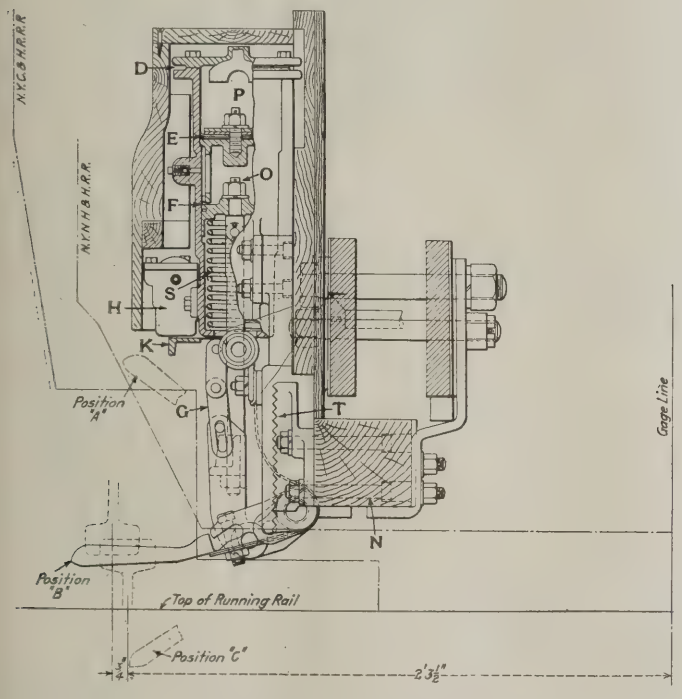


Fig. 3—Type of Shoe Used for Both Overrunning and Under-Running Third Rails

rail by any one of the many substations, is several thousand amperes at 600 volts, on the swings or peaks, it is necessary to set the circuit breakers to trip out, in these substations, at a comparatively high setting, say approximately 8,000 amperes. Conditions could arise where the short-circuit arc would not require sufficient current to blow the breakers in the substations, so that the emergency feature is a desirable one. An interesting point in this connection is that when the third rail shoe leaves the rail, even with the heavy main motor current passing through the shoe, an electric arc does not persist but is quickly disrupted due to a magnetic blowout action.

The details of the shoe and operating mechanism are shown by Fig. 3. The assembly is mounted on a shoe beam *N* which is supported from the truck. Adjustment for height is taken care of by a series of teeth *T* as in the other shoe. It is not as practical in this case to adjust the casting on the beam, due to the size of the mechanism as it is to adjust each end of the beam at its point of support, so that the latter arrangement is followed.

The operation of the shoe is remotely controlled from the inside of the locomotive and air pressure is used for this purpose. The normal position when on the New Haven is at *position A* inside of the clearance line. To put the shoes "down" ready for third rail operation, air pressure is admitted to the top compartment *P* of the cylinder *D*. The piston *E* is pushed down, also forcing down the lower piston *F* to which is fastened the piston rod connected to the shoe. The piston *E* has a definite travel and when it reaches the position as shown in Fig. 3 the shoe is in the operating position, indicated as *position B*, when the shoe reaches *position B* it is held there by the latch lever or toggle *G* which is carried by "center."

When in the "down" position or *position B*, the shoe is tripped by putting air pressure in the small latch cylinder. A plunger strikes the casting *K*, pushing the latch back and the main cylinder spring *S* pulls the shoe back to *position A*.

The emergency position of the shoe is shown at *position C*. It will be noted that when the shoe is in the operating position that piston *F* has not moved its full distance. There is approximately an additional inch before the lower edge of the piston will bring up against its stop. This extra travel is allowance for the emergency position. The shoe is carried to *position C* by putting air pressure in the compartment *O* between the two pistons. Piston *E* is pushed back to its normal position and piston *F* down to its full travel.

In the next article we will discuss the methods used in running the main cables from the third rail shoes through the shoe fuse boxes to the main switch in the locomotive.

ST. PAUL USES GIN POLE MOUNTED ON PUSH CAR

A record in the rate of setting up trolley poles along the track of the Chicago, Milwaukee & St. Paul Railway has been made by the use of a gin pole built up on a push car and operated along the track. Using this device, poles up to 50 ft. long have been set with a crew of four linemen and about three helpers, including a teamster, the team being used for hoisting the trolley pole and moving the push car from setting to setting. Additional men, of course, were used to line poles and backfill, following the setting crew.

With this rig the rate of progress has been as high as 108 settings per day and has averaged about seventy poles per eight-hour day. Before the portable gin pole was built the average made by the hand method was about fifty poles per day, and this meant hard work on the part of the crew. The gin pole has a total length of about 18 ft. and is slung, about 6 ft. from its lower end, on a horizontal pin supported on a heavy frame built up from an ordinary push car. The gin pole itself is strengthened with longitudinal steel cables passing over central struts so as to form trusses.

INCOMING AND OUTGOING FEEDERS

By A. L. Johnston

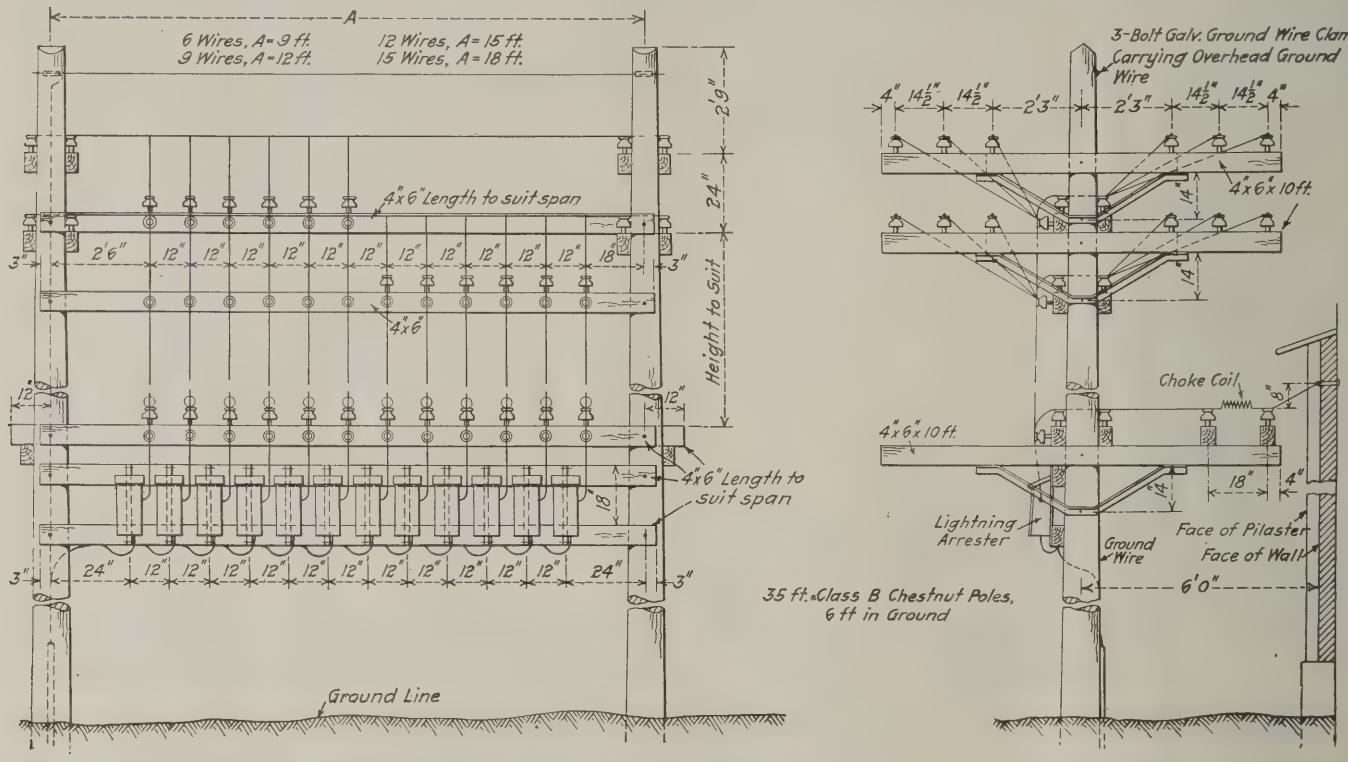
It very frequently happens in the design of an electric system that the engineering in connection with the power-house and substations is worked out very carefully while little attention is paid to the pole fixture outside to take care of the incoming and outgoing feeders. Especially is this true with smaller installations where the cost of steel towers or steel poles is not warranted. These construction details are frequently left to the practical line-man to develop as requirements demand. The result is that provision is made only for immediate needs and the fixture is erected in such manner as to make changes and repairs after the lines are energized expensive as well as dangerous.

In making plans for taking care of the incoming and outgoing feeders the engineer should arrange his pole construction so as to provide for many more additional circuits than are at that time contemplated. He should so arrange his fixture that it is in reality a transfer tower on which he can make connection from any feeder to any other feeder or can parallel his feeders without complicating his wiring. He should make provision for mounting lightning arresters, disconnecting switches and choke coils, even though he does not at that time mount the apparatus. It is usually more desirable and economical to mount these outside instead of inside the power-house or substation. Most important of all he should make his design such that where necessary, work can be done on this fixture while maintaining continuity of service and at the same time with as much safety as possible.

The illustration shows a design which it is believed embodies these features. The disconnecting switches are not shown but can be mounted in the same manner as the choke coils, being mounted on the same crossarms. Provision was made as shown in the figure for carrying an over-head ground wire on the top of the pole. The cross-arms are not standard but are 4 in. by 6 in. by 10 ft. yellow pine. The additional length is provided to give ample climbing space and 4 in. by 6 in. material is used instead of the 3½ in. by 4½ in. on account of the circuits which are dead-ended on these arms.

The lightning arresters are connected so that there are no sharp angles between the arresters and the out-going lines and for the same reason the line to the station is attached to the vertical wires so as to introduce a sharp angle and thereby provide additional protection if possible.

Where more than the number of the circuits shown in the figure are to be taken care of, three or more poles should be erected in the same line carrying out the same idea.



Wood Pole Structure for Incoming and Outgoing Feeder Lines at Sub-Stations and Power Stations

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Progress in Valuation Work, according to a statement made by Director Prouty before the Appropriations Committee of the House of Representatives on February 3, 1919, is such that road and track parties in all districts will substantially complete their work this year. Four parties have already been disbanded in the Pacific district and five in the Southern district. Land and field and accounting work will be completed in about two years, while the office work will be completed in about three years. It is estimated that the Division of Valuation will receive completed reports from the engineering section on 50,000 miles of road during 1919, similar reports having been received on 25,000 miles of road up to January 1 of this year.

Pennsylvania Three-Point Supported Turntables

Table Has Two Tractors, Universal Controller and Collector Mounted Rigidly on Center Portal

A CENTER bearing adjustable vertically over a range of one inch by means of screw operated wedges is one of the main features in the 110-ft. turntables recently designed by the Pennsylvania Railroad and which are now being installed at certain of its more important engine terminals This vertical adjustment has permitted the development of plans for tables of the three-point supported type, the design of which includes many novel and interesting features, especially in the avoidance of the use of tables of the usual balanced type with their objectionable features, and particularly in tables of such extreme length.

These 110-ft. turntables were designed in anticipation of the increased requirements at engine terminals, incident to the impending introduction into service of the new Mallet engines of the HCls type, one of which is now under construction in the company's Juniata shop. These locomotives have a wheel base of 97 ft. 3¾ in., and overall length of 105 ft. 9¼ in., and an estimated weight of 555,000 lb., exclusive of the tank, which weighs 219,000 lb., or a total weight complete of 774,000 lb. Owing to the extreme depth of turntable girder required for a balanced table of such great length, and further because of operating conditions which make it difficult to spot a locomotive of this size and weight with any degree of accuracy, it was deemed inadvisable to construct the turntable along the usual lines of the balanced type of table. Furthermore, the teetering action of the balanced type of table has an undesirable effect on the approach rails and outside trucks due to pounding, which is seriously augmented as the table length increases. It was, therefore, decided that the new tables should be of the continuous girder type, three-point supported, with the weight of table and its load distributed over the center and four end trucks. Exclusive of tractors and center the table completed, including the end trucks, has a weight of approximately 75 tons.

Reliability of service, together with low maintenance costs, were the main objectives of the design, while in the preliminary studies particular attention was given to the requirements of traction. Time studies were made of the various turntable operations at existing tables and the information thus secured was utilized in the design of the 110-ft. turntable tractors to ensure that the operating cycles of the new table with its greater loads would not exceed those of the smaller tables, and that the new tables would be able to turn an engine end for end in 60 sec. Special attention was given to starting and stopping of the table in order to avoid excessive whip action, with the result that the maximum acceleration does not exceed 0.35 ft. per sec. per sec., with a maximum circumferencial speed of the table of 240 ft. per min. Reliability of service has been further provided for by the utilization of two tractors, either of which is capable of turning the table under emergency conditions. These two tractors are provided with sufficient traction to eliminate the use of sand for traction purposes and the consequent hard running of the turntable trucks due to increased rolling resistance. These two tractors travel on the same circle rail as the turntable trucks.

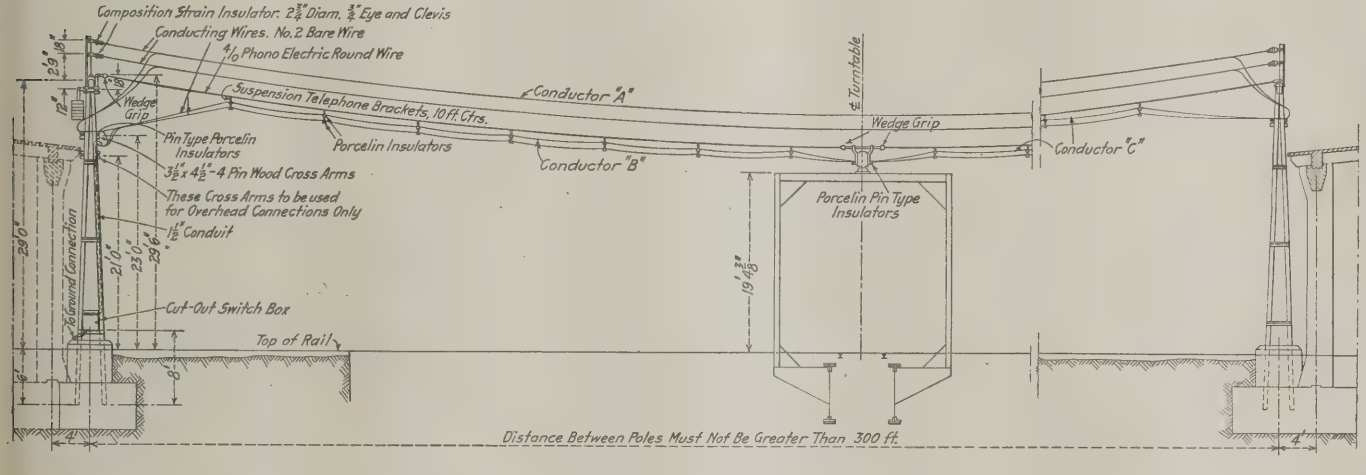

Composition Strain Insulator. 2¾" Diam. ¾" Eye and Clevis
Conducting Wires. No. 2 Bare Wire
4/0 Phono Electric Round Wire
Suspension Telephone Brackets, 10 ft. Ctrs.
Conductor "A"
℄ Turntable
Wedge Grip
Pin Type Porcelin Insulators
Porcelin Insulators
Conductor "B"
Conductor "C"
3½ x 4½ - 4 Pin Wood Cross Arms
These Cross Arms to be used for Overhead Connections Only
1½" Conduit
Porcelin Pin Type Insulators
#6 Ground Connection
Cut-Out Switch Box
Top of Rail
Distance Between Poles Must Not Be Greater Than 300 ft.

Fig 1. Diagram Showing Catenary Construction and Method of Mounting Current Collector.

Low maintenance costs are further insured by the permanent character of construction employed throughout the foundation, circle rail, circle wall, bridge, deck and electrical apparatus. In the design of all parts simplicity, accessibility and interchangeability are the chief objectives. Cast iron was utilized wherever possible on account of its resistance to corrosive action. For the same reason galvanized iron was used for hand rails.

To eliminate the pounding out of approach rails and approach rail supports at the table ends and at the approach rails, cast steel end ties were installed at the ends of the turntable bridge and cast iron coping castings used on the coping wall, the cast steel end ties being aligned to the exact center line of the turntable bridge and brought to alignment level by means of stereotype lining between the end tie and the girder flange plate and

secured to the turntable bridge by means of eight 1 in. bolts. Diametrically opposite tracks to the turntable are also perfectly aligned. The same permanent character of construction is employed in the pit where the circle rail, Cambria No. 539, 150 lb. per yd., bent cold, is held in place on 33 cast iron support castings firmly secured to the concrete foundation. The adoption of the three-point supported type of turntable permitted the use of girders only 6 ft. ½ in. deep, materially reducing the depth of turntable pit required. These pits are drained from the center to a sump from whence the discharge is by gravity or syphon, according to local conditions.

The Center

In order that this table should function properly on its three points of support, it is necessary that one of these supports be adjustable as far as vertical alignment is concerned. This adjustment is accomplished at the center by means of screw operated wedges, the total range of adjustment being 1 in. As the load of the table comes down on the sole plate it bears on wedges, which in turn, through their wedge casting, bear on the equalizing hinge pin, thence on the thrust bearing proper. This thrust bearing is of the roller type with a babbit liner between the lower roller race and the center casting to insure uniformity of bearing pressure. The load from the turntable center is transmitted to the concrete center pier through ¼ in. linotile liner, which insures a uniform resilient bearing for the steel casting on the concrete. The capacity of this center bearing is 860,000 lb. and is fully grease lubricated. It has been designed and built with a view of making it accessible for inspection and repairs. The upper half of the center proper can be removed from the base casting and the entire center slid out of position and passed up through the deck of table; to perform this operation it is only necessary to jack up the table approximately 3 in. All the adjustment wedges and the wedge screws are thoroughly protected against corrosion and grit. The center is entirely of steel except for the housing shell which is of cast iron.

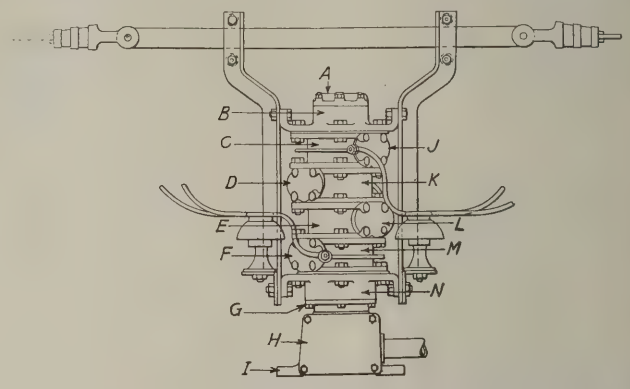


Fig. 3. Current Collector For Two Phase Four Wire Service.

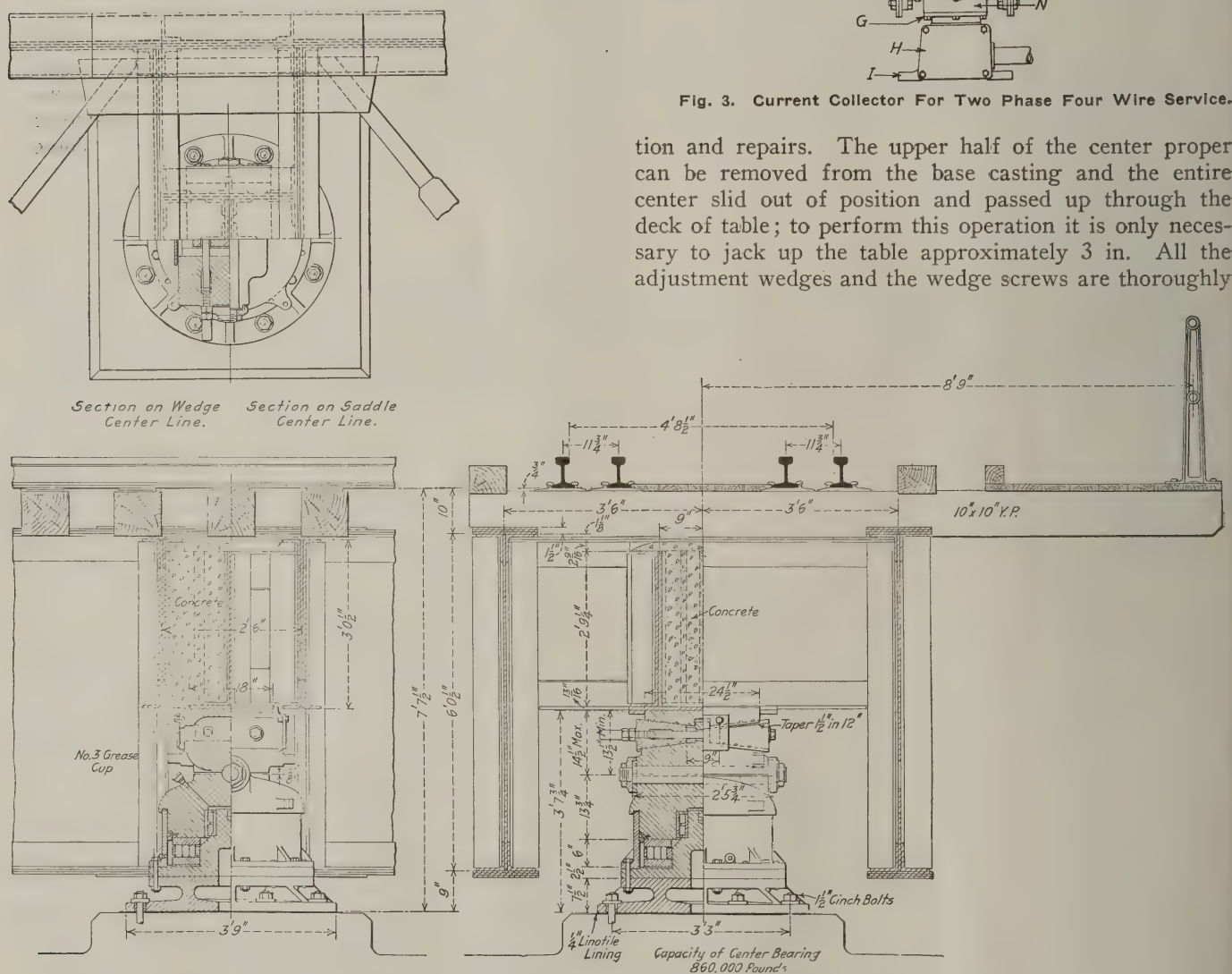


Fig. 2. General Arrangement of Center.

Current Collector

Overhead current collectors for the usual type of balanced turntables must be suspended from overhead wires, owing to the fact that any portal construction over the

center of the table must necessarily oscillate back and forth over a considerable distance when the locomotive is moving on or off the table. Since stability in this direction is secured in the table through three points of support and the table does not rock on the center bearing, the collector is securely bolted to the center of the portal. The collector in itself is of particular interest in that it is of the sectional type made up of standard parts and may be used for direct current or one, two or three phase alternating current collection as required. It is weather, gas and steam proof.

The side elevation of a collector made up for 2 phase, 4 wire service is shown in Fig. 3. This illustration shows the manner in which the messenger is attached to the collector. The collector is bolted rigidly to the center portal through the flanges I. It is desired to use the collector for direct current collection, any two of the sections C, K, E, or M, may be dispensed with. Access to the brushes may be had by removing the wire, two-phase, conductors A and B are eliminated. For single phase or direct current, conductors A, B and C are eliminated.

Tractors and Tractor Control

Two tractors are used on each table to give uniform torque action on the table in starting and stopping as well as to afford reserve power to meet emergency demands. These tractors are operated in multiple from one controller located in a cab at one end of the table.

There are three points of particular interest in connection with the tractors and their control. The first is that two motors are used, one on each tractor, of approximately 30 hp. each. This is considerably more power than is used on the ordinary type of table. A table of this kind does require more power for operation than one in which the locomotive is balanced on the center bearing, but the operation is fast and must always be dependable, and one tractor, working alone, can be

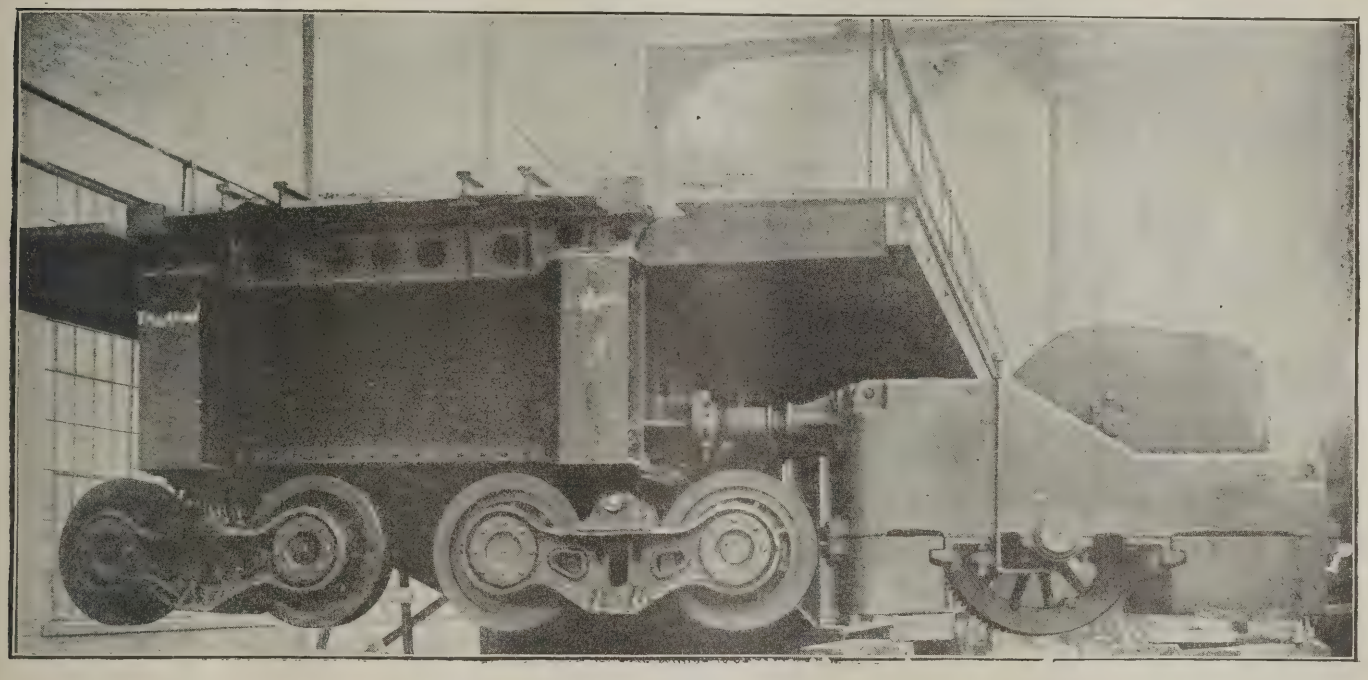


Fig. 4. Trucks and Tractor.

plates J, D, L, and F. Grease lubricated roller bearings are provided at the top and near the bottom of the collector.

Catenary Construction

Structural steel poles placed on opposite sides of the engine-house circle support the overhead wire. One messenger wire is provided instead of the usual two and it is not required to support the current collector. The only function of the messenger is to support the current carrying wires and to prevent movement of the stationary part of the collector. One end of the messenger is rigidly supported at one tower and the other end fastened to a bell crank used to compensate tension due to temperature. This bell crank supports a series of weights, which insure uniform tension on the messenger at all temperatures.

The arrangement of the steel poles and catenary construction is shown in Fig. 1, for two-phase four-wire operation. For three-phase alternating current, or three-

used to operate the table, if necessary, in an emergency.

The second point of interest is the controller. A type of controller has been developed which is used to control one or both motors, and which may be used on any table of this type without regard to the kind of electric power available. The same controller may be used for direct current, single phase alternating current, three-phase alternating current, and three-wire or four-wire two-phase current. A change of connections is all that is required to adopt the controller to any kind of power supply. The direct current and the three-phase alternating current connections are shown in Fig. 5.

The third point of interest lies in the fact that the motors are equipped with solenoid brakes. These brakes are applied instantly when the controller is moved to the "off" position and are released automatically when power is turned on. The brakes are so adjusted that the braking effort corresponds to the maximum torque of the motor. With this type of solenoid brakes it is

possible to operate the table without any of the so-called locking devices to hold the table in alinement with the approach tracks.

For direct current, 27½-hp. motors are used while 30-hp. motors have been adopted as standard for alternating current. Power is transmitted from the motor to the driving wheels through two sets of gears and intermediate shaft with a total gear reduction of 25 to 1. As the tractor is provided with plain cylindrical tires, it was necessary to include in the design a suitable thrust bearing to take care of lateral thrust on the drive wheel of the tractor, which thrust bearing is located on the inner side of the tractor frame.

working order, giving a total tractive effort of 12,000 lb. per table.

The tractor frames, on account of the weight required, are made of solid cast iron with suitable ballast weights suspended from the lower surfaces. Special attention is given to the machining up of all mechanical parts with a view of ensuring absolute interchangeability for repairs. All gears are fully enclosed against the weather. The tractor wheels have cast iron centers, steel tires, and are provided with cast steel cut gears. All bearings are of brass.

When operating at night the table is lighted at each end by floodlights which illuminate the approach rail

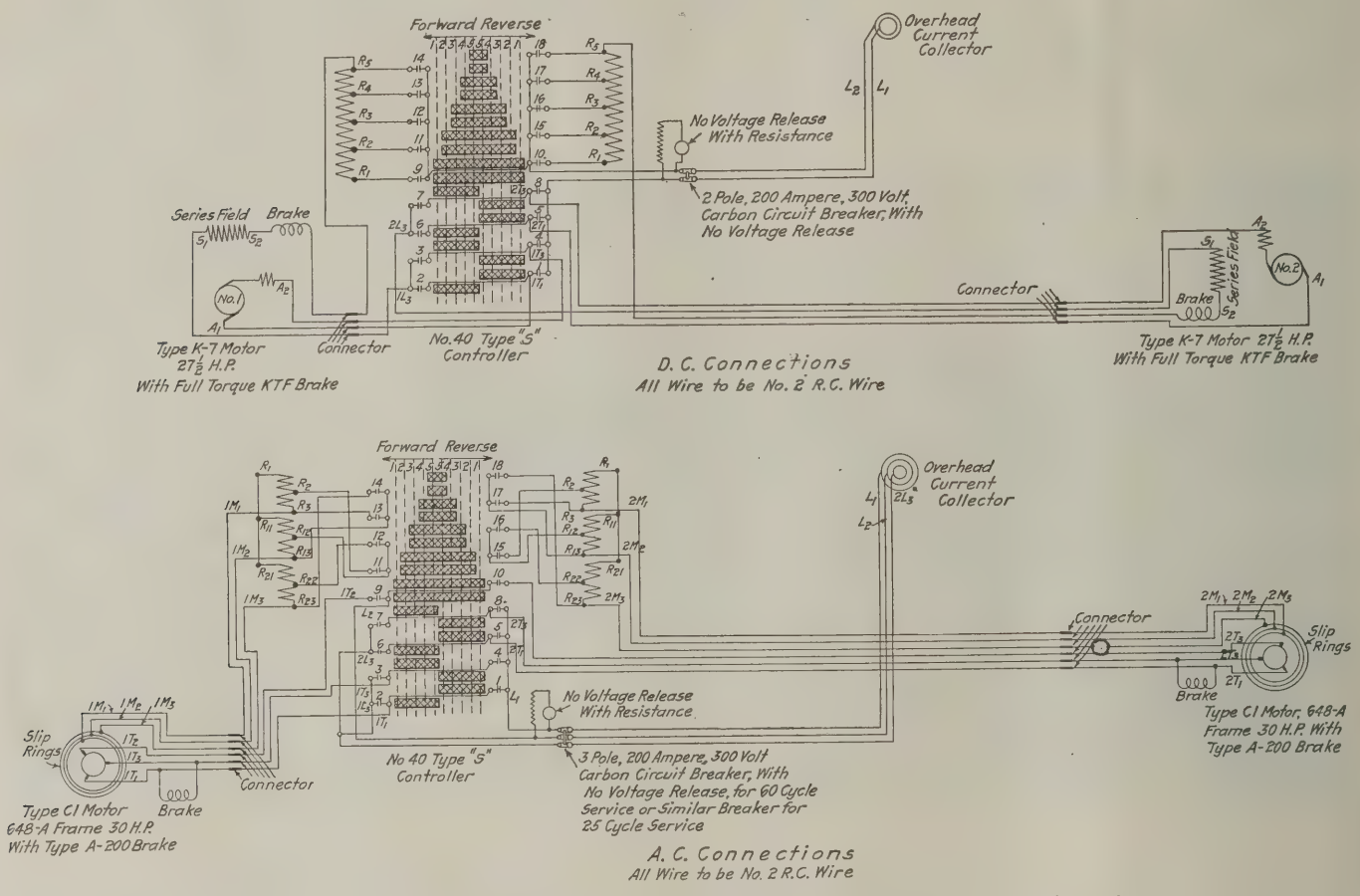

Forward Reverse
Overhead Current Collector
No Voltage Release With Resistance
2 Pole, 200 Ampere, 300 Volt Carbon Circuit Breaker, With No Voltage Release
Series Field
Brake
Connector
No. 1
No. 2
No. 40 Type "S" Controller
Type K-7 Motor 27½ H.P. With Full Torque KTF Brake
D. C. Connections
All Wire to be No. 2 R.C. Wire
Type K-7 Motor 27½ H.P. With Full Torque KTF Brake
Forward Reverse
Overhead Current Collector
Slip Rings
No Voltage Release With Resistance
No 40 Type "S" Controller
3 Pole, 200 Ampere, 300 Volt Carbon Circuit Breaker, With No Voltage Release, for 60 Cycle Service or Similar Breaker for 25 Cycle Service
Type CI Motor 648-A Frame 30 H.P. With Type A-200 Brake
A. C. Connections
All Wire to be No. 2 R.C. Wire
Type CI Motor, 648-A Frame 30 H.P. With Type A-200 Brake

Fig. 5. Wiring Diagram for Direct Current and Three Phase Alternating Current Operation.

In case of accident to either motor or to any part of the driving mechanism, electrical cutouts are provided for cutting the damaged motor out of service without affecting the operation of the other motor, while the solenoid brakes can be blocked in "off" position. A motor may be disconnected mechanically by removing the split main gear or by removing the motor itself.

All of the wiring on the table is run in conduit except for a short distance between the table and the tractor where the wiring is open. Flexibility is required at this point as there is a certain amount of relative movement between the tractor and the table. Knuckle-joint connectors are provided at this point for disconnecting the wiring in case the tractor is removed from the table.

The two tractors engage the table through ball and socket connections located at the end of the stabilizing arms. All bearings of the tractors are grease lubricated. The tractor weighs approximately 23,000 lb. in

ends. The operator's cab is electrically heated and is lighted with a small, well shaded lamp to keep down the reflection at night.

Trucks

The end trucks on the table are of the cast steel frame type with hinge connection centers. The hinge casting is provided with a compound angle in order to give proper angularity in all directions. The center line of hinge pins are in radical planes intersecting at the common center of rotation. All truck wheels are 30 in. in diameter, coned, with steel tired treads and cast iron centers. They are provided with roller bearing centers, the bearing being enclosed in a labyrinth casing, the details of which will be clear from an inspection of the truck drawing. The trucks are fully grease lubricated.

The truck hinge castings as well as the steel end ties on top of the girder are lined to the girder flanges by

means of stereotype metal. The trucks each have a capacity of 186,000 lb. and travel on the same circle rail as the tractors. They may be readily removed by taking out the hinge pins located in the hinge castings at the girder.

Coping Wall

In order to ensure against settlement at the coping wall on account of pounding due to the engines coming on and off the tables cast iron coping castings were employed instead of wooden sills. These castings are arranged one for each approach track and are thoroughly embedded in concrete and bolted thereto. They are accurately aligned to the approach tracks, weigh about 9,000 lb. and are 5 ft. 6 in. long, 12 in. deep and 30 in. high. They are made of one-inch material.

The circle rail on which the trucks and tractors run is 106 ft. in diameter and supported on 33 support castings each 9 ft. 4 in. long, 10 in. high and 12 in. wide and made of 7/8 in. material.

The cast steel and tie on the bridge has a maximum depth of 12 in., a minimum depth of 8 3/8 in. and a flange width of 5 in., and is made of one inch material. It supports both the traction and guard rails and is lined to the bridge girders by means of 3/8 in. stereotype lining.

The design of this table was developed under the direction of Mr. A. S. Vogt, Mechanical Engineer (now retired on age).

Tables of this type have been installed at Pitcairn, Pa., South Philadelphia, Pa., Erie, Kan., Renovo and Gardenville, N. Y. Others will be installed in the near future at Wilmington, Del., Youngwood, Pa., Pitcairn, Pa. emergency table and at East Altoona.

DEVELOPMENT OF A LEAD BURNING TRANSFORMER

By L. E. Klingman, Transformer Engineering Dept., General Electric Co.

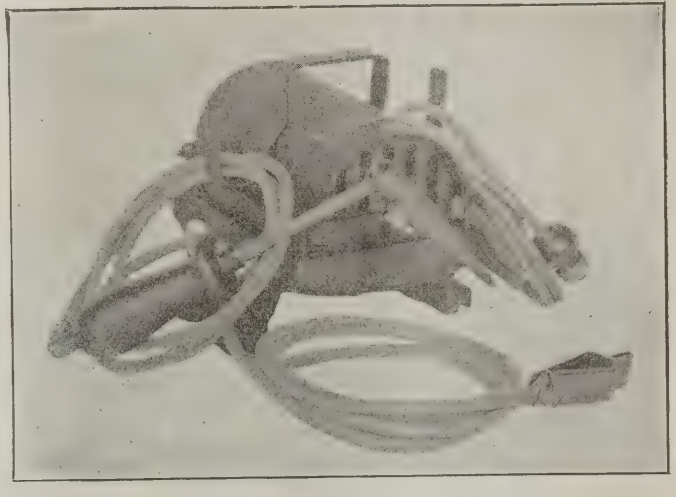
There has been a great demand for some means of burning posts and straps on storage batteries other than those which are at present employed, namely, oxy-acetylene and oxy-hydrogen. An Electric Lead Burner has been developed by the General Electric Co. for this purpose.

Several schemes were tried with the application of electricity. One was the use of an arrangement similar to an arc welding outfit using a storage battery to supply the energy. The conductor from one terminal of the battery was fastened to the post or strap to be burned. The other was attached to a piece of material having a high thermal and relatively high electrical resistance, such as carbon. Upon bringing the carbon in contact with the lead, energy is used up in high contact resistance between the carbon and lead. The carbon point quickly becomes heated up to incandescence and furnishes the heat to puddle the lead. It will be noted that this was not an arc welding process, and that no arc was drawn during the burning, but the nose of the carbon was kept immersed, perhaps 1/16 in. in the lead.

When the battery to be burned had a sufficient number of cells, three or four of its cells adjacent to the joint to be burned were used to supply the energy. The conductor or jumper having a carbon electrode was fastened to a cell terminal three or four cells away from the work, and the circuit was completed through the carbon and the post or strap to be burned on the battery. Either of these methods, however, have the disadvantage that the battery used to supply the energy must be up to full charge in order to furnish sufficient power, and that after the burning is completed, the battery is completely discharged. For this reason these methods are not practical or economical.

Another scheme of incandescent welding or burning was developed using a transformer. The primary took power from an electric light circuit—the secondary or low voltage side furnished power through a duplex cable lead to a piece of nichrome resistance wire serving as a heating unit for melting or puddling the lead. This was an improvement over previous idea. However, due to the fact that the secondary leads were large and cumbersome, and the heating unit crude, satisfactory results could not be obtained.

After careful study and several experiments, a method was developed using a combination of both of the above schemes. The transformer takes energy from the lighting circuit and delivers energy at about 6 volts at the secondary terminals. Secondary leads, originally cotton covered, were brought out separately, one conductor terminating in the carbon holder and the other in a spring clip to connect to the work. In this case the carbon point is heated by contact resistance as in the first method above. With this arrangement the lead is melted and puddled to compare very well with gas burners.



Lead Burning Transformer and Equipment

This outfit seemed promising, but after first trials it was found necessary to make several improvements. As the leads are continually exposed to the corroding action of the acid, they were replaced by a rubber-covered cable which was not affected. Another improvement was the design of a better carbon holder and handle so that the carbon would be some distance from the wood handle, as it was found that the temperature attained was sufficient to burn it or to heat it up so that it could not be handled by the operator.

The new carbon holder is made in the same style as the torch used in gas burning, which the operators are accustomed to manipulate. It is composed of three principal parts, namely, a coil spring, handle and a carbon

holder. The phosphor bronze spring screws into the handle and serves to keep the conductor from wearing at the entrance to the handle, and also assists the operator in controlling the electrode. The handle is made of wood and is turned to fit the hand nicely. The brass carbon holder is made in an "L" shape, the stem being longer and somewhat smaller in diameter than the holder. The cable passes through the spring and then through the handle into the binding post formed in the enlarged end of the stem, where it is secured by a set screw. The set screw also serves the purpose of securing the carbon holder into the handle.

The carbon holder is designed to admit 5/8 in. carbon, which is clamped by a thumb screw. Carbons can be changed very readily.

The phosphor bronze clip used for connecting to or grounding the circuit has a very strong spring, insuring good contact, and can be easily removed and placed in any desired part of the work to be burned.

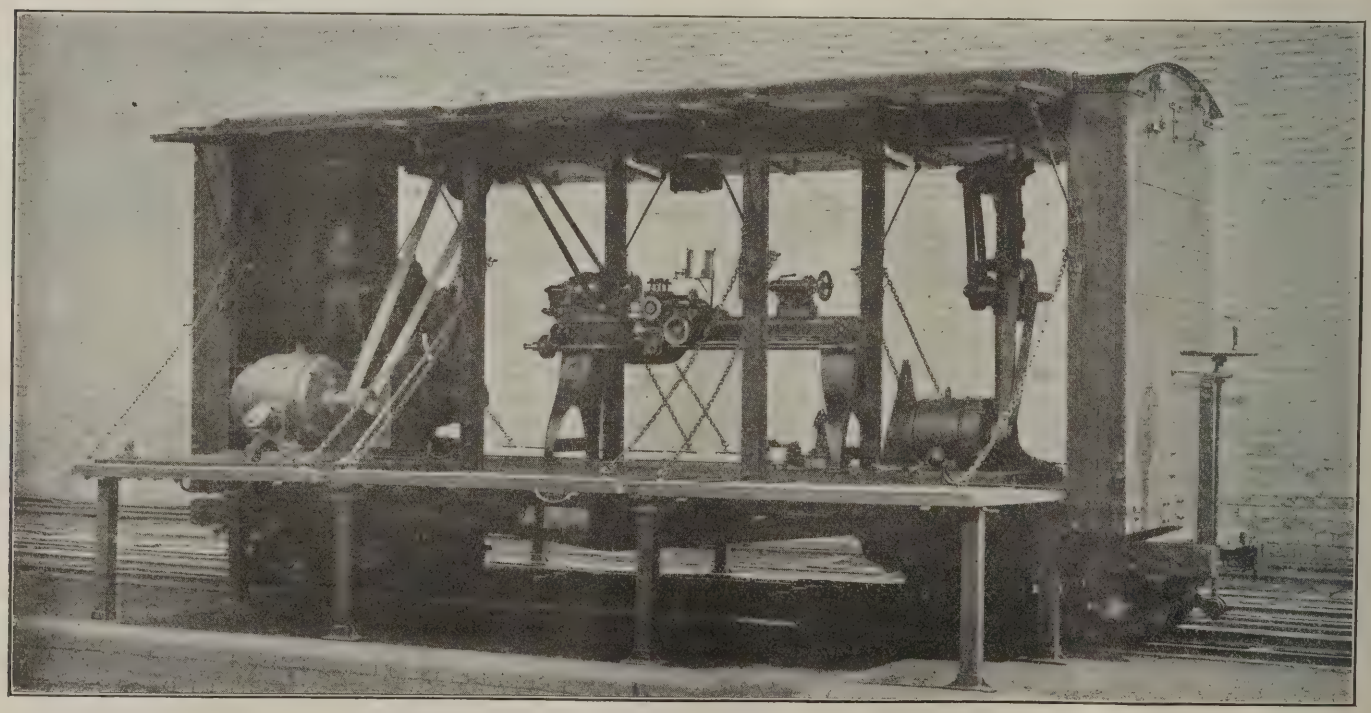
The transformer weighs only 25 lb. complete, and is portable. An iron strap is fastened on the case in such a way as to form a convenient handle for carrying, and to form convenient hooks for hanging the conductors while not in use.

A REPAIR SHOP TRAIN ON A NARROW GAGE ROAD IN FLANDERS

One of the unusual features of transportation in the war zone was the system of a narrow gage military railway. The 16 cm. (1 ft. 11⅝ in.) gage roads operated by the British in Flanders had some interesting equipment, of which none was more novel than the mobile workshop repair trains constructed by the Gloucester Railway Car & Wagon Company, Gloucester, England. Six of these trains, each consisting of six cars, were built to the requirements of the Director General of Light Railways and Roads branch of the War Office and the Railway Material branch of the Ministry of Munitions for use on the lines serving the standard gage railway system. The train comprises a generating car, two machine shop cars, a tool car, a supply car and an officers' car. The over-all dimensions of each unit are the same, being as follows: length over body 17 ft. 8½ in., width over body 5 ft. 4¾ in. and height from top of rail to top of body 9 ft. 1 in.

The generating cars are fitted with two direct connected gasoline driven electric generator sets each with 15 to 20 hp. engines and 10 kw. generators. These sets weigh approximately three tons each. The gasoline is carried in tanks at each end of the car and water tanks are placed below the under frame, while the muffler is located on the roof. In the center of the car there is an air compressor driven by a 10 hp. motor and connected to an air reservoir slung from the roof. The total weight of this car is approximately 8½ tons.

The machine shop car is furnished with a duplex wheel emery grinder, a 30-in. grindstone, a rapid hack saw, and a vertical drilling machine. The first two machines are connected to overhead shafting which is driven by a 3 hp. motor, while the other two are driven direct, each having a 2 hp. pipe ventilated motor. Electric lights are placed over each machine. The electrical connection between the cars is made by means of insulated cables which are plugged into special fittings on the end of the car. The total weight of this car is 5 tons. The second machine shop car contains one 8 in. shaper driven by a 1½ hp. variable speed motor and a 6 in. lathe with a 21 in. chuck driven through a countershaft attached to the roof by a 2 hp. motor on the bottom portion of the falling side. There is also a small drilling machine in this car fitted with a chuck and driven by a 2 hp. motor. The weight of this vehicle is about 5¼ tons.



Machine Shop Car Showing Motor Mounted on Hinged Side Panel

PRACTICAL STUNTS

How the Brakemen Help

By Hinkey Dee, Himself

I noticed in the Practical Stunts columns of the May issue an article backing up the statement about brakemen helping out on car lighting, but I am sorry to say that me and Jimmy Goat have had a change of mind.

Now we don't mean to be bulshivekers but we find that since we have had the assistance of the passenger conductors, brakemen, newsboys, dining car stewards, cooks, waiters and Pullman conductors and porters it is impossible for a car lighting equipment to remain in a healthy condition for a longer period than ten hours. Then it has to be shopped for a general overhauling.

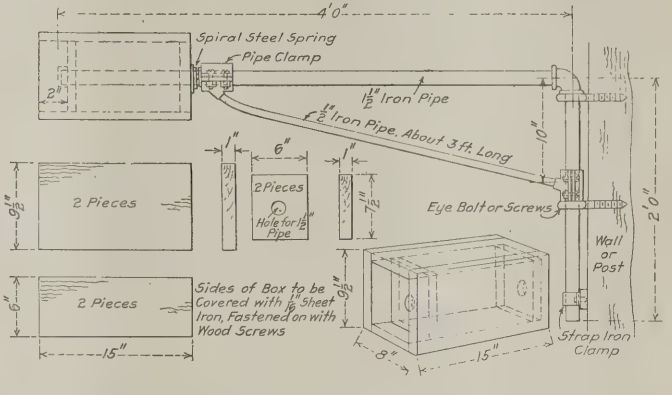
Why! One time we found the entire train crew arguing about a generator regulator. The orator of the occasion in an endeavor to brighten the lights closed the automatic switch 22 times in succession while the car was standing and each time he blew a generator fuse. Finally he run out of fuses and decided to ask me. After me and Jimmy explained it all to him he said he thoroughly understood and the car hasn't arrived since without a generator fuse blown. It may be that this brakeman who understands all about car lightin' is blowing the fuses in an effort to knock the theory into "Mike, the other brakeman's head." At any rate, let's hope so.

Bracket and Form for Lead Burning Work

By J. G. Eberler,
Shop Engineer, 47th St. Shop,
Chicago, Rock Island & Pacific, Chicago.

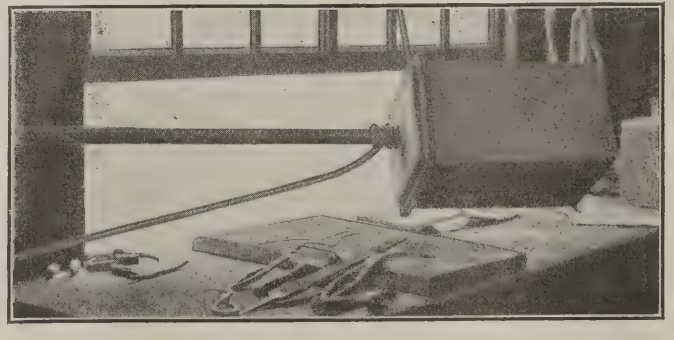
Almost every railroad has one or more storage battery charging plants for charging car lighting batteries. Usually, in connection with such a plant there is also a repair section for making various repairs to damaged storage cells. Lead containers or tanks often require patches. These vary in size depending upon the size of the leak. Such repairs are made by means of a lead burning outfit. In order to assist in doing the work, the lead burning repair section in the storage battery charging plant of the Chicago, Rock Island & Pacific at its 47th St. shop is equipped with a convenient device which consists of a pipe bracket provided with a form which just fits inside of a 13 plate lead tank. Larger tanks can also be repaired by means of the form, but it is necessary to move the tank from one side to the other when working on each wall of the tank.

The photographic reproduction of this device shows one of the 13 plate tanks applied to the form. The other illustration shows the general design of this device with the necessary dimensions. The bracket which holds the form is made of 1½ in. iron pipe fitted with ordinary



Details of Form and Bracket.

pipe fittings. The diagonal support consists of ½ in. iron pipe with its ends fastened in pipe clamps. The vertical portion of the bracket fits into two "I" bolts, which are fastened into the wall of the building next to the lead burner's working bench. One pipe clamp for



Bracket and Form in Use.

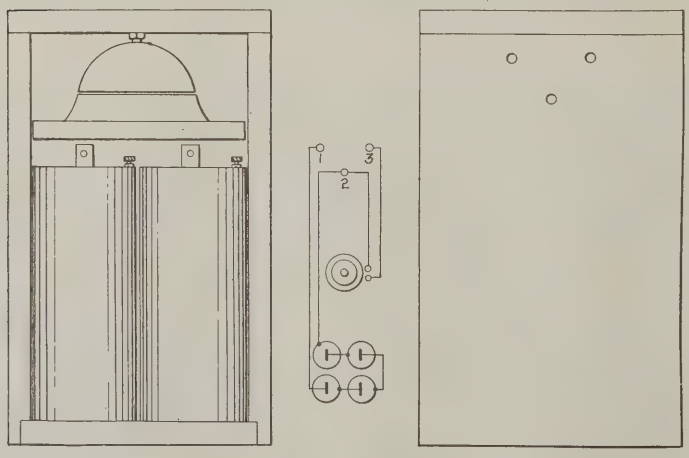
holding the diagonal piece of pipe is fastened just above the lower "I" bolt and the upper "I" bolt comes just below the pipe elbow. These furnish the necessary support for the bracket so that it will not slip down. A few inches below the lower "I" bolt is an iron strap which spans the vertical pipe to assist further in keeping it in place. Another feature of this device is the short spiral spring between the form and the pipe clamp on the

horizontal bracket arm. This spring serves to hold the form rigidly in place after it is turned from one point to another about the horizontal pipe. The form itself consists of a hollow wooden box made of one inch lumber as shown in the illustration. The outer surface of this box is fitted with 1/16 in. steel plate which serves as a firm foundation for working the lead tanks into shape by means of wooden mallets. When a lead tank is put on this form it is necessary to shape each lead surface to this metal plate so as to provide a firm foundation before cutting out the bad spots and also for holding the patch, cut to proper size, flush with the face of the tank when the process of lead burning is underway.

Testing Outfit for Parlor Car Bells

By E. C. Meilloret, Electrical Repairman.

In testing out parlor car bell and annunciator wiring, I have often found it necessary to have an extra set of batteries and also an extra bell as trouble is just as liable to develop in the bell as in the battery. In order to make this outfit portable and practical, I have had arranged four dry cells in a neat wooden box made of poplar, 5/8-in. thick. A piece of wood about 1/2-in. thick is cut square so as to fit on top of the battery as shown in the illustration. To this square block is screwed a 3-in. monitor bell and on top of this comes the cover of the box. The important feature is the manner of connecting the outfit. Three binding posts are arranged on the front of the box as shown in the sketch. These posts are numbered



Arrangement of Cells and Wiring Diagram of Testing Outfit

1, 2 and 3, the battery being connected to binding posts 1 and 2 and the bell to posts 2 and 3.

If a car is found in which the bells do not ring either the batteries are dead, the bells are out of adjustment, or a wire is broken.

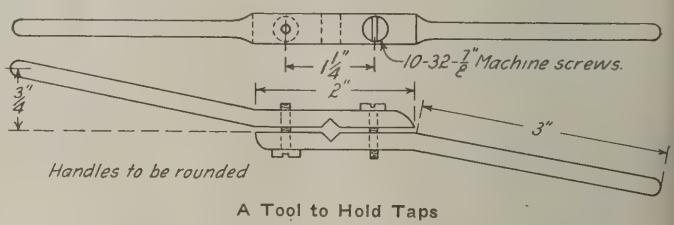
If it is suspected that the batteries are dead this fact may be verified by disconnecting them and substituting in their place the test battery by connecting the battery leads to binding posts 1 and 2. If the battery was at fault you will probably find everything O.K. when the test battery is used as a source of current. If, however, you get no results you must look elsewhere for the trouble.

The next step is to connect the old batteries to the posts 2 and 3. If you get a ring then you know that the batteries are still good and you may turn to the annunciator, which possibly may be out of adjustment. By connecting this bell to posts 1 and 2 your test battery gives you an opportunity to make whatever adjustments are necessary. Again by connecting two long wires to posts 1 and 3 you have a bell circuit in which you may locate grounds or broken wires.

Of course, the builder may use his own judgment as to the style of handle he wishes to use. Personally, I find that an ordinary strap fastened to the sides and running over the top of the box answers every purpose. I have found this outfit very handy and practical.

A Wrench for Tap Bolts

The illustration shows a convenient wrench for holding taps used in cutting threads for the screws. This wrench is made from a 10-in. piece of 3/8-in. square steel cut in two parts. Three inches on one end of each piece is slightly rounded to form handles

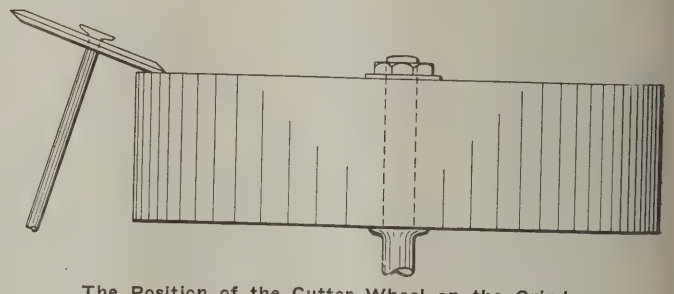


A Tool to Hold Taps

and bent on an angle of approximately 60 deg. with the square section. The opposite end from the handles on each piece is cut as shown to hold the tap and provided with screws to permit piping of the wrench on the tap.

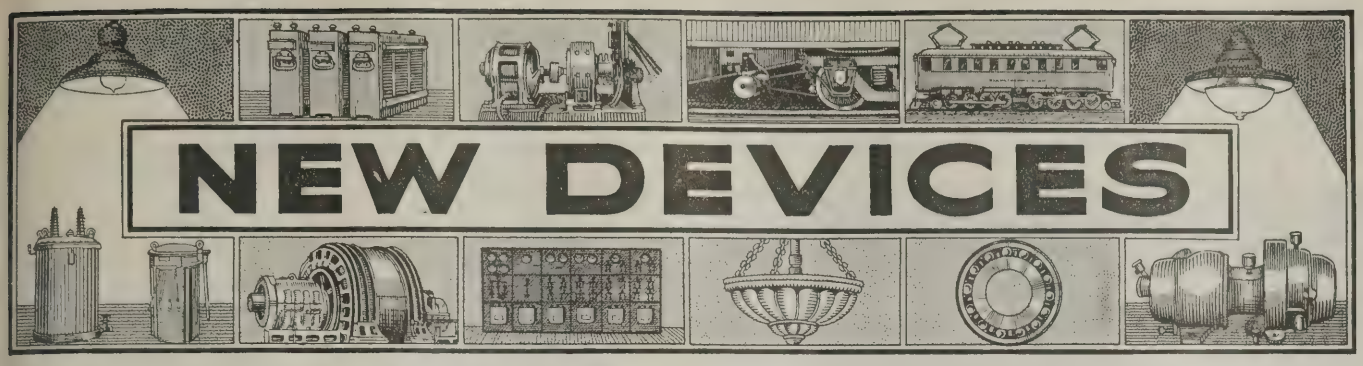
How to Sharpen Pipe Cutter Wheels

When the cutting wheels of a pipe tool become dull, some consider it necessary to discard them and install new wheels. To throw them away is wasteful, because they can be sharpened and made almost as good as new. In order to sharpen dull wheels it is necessary to remove them from the tool holder and place each wheel on a 60-d wire nail or small bolt that can be used as a shaft.



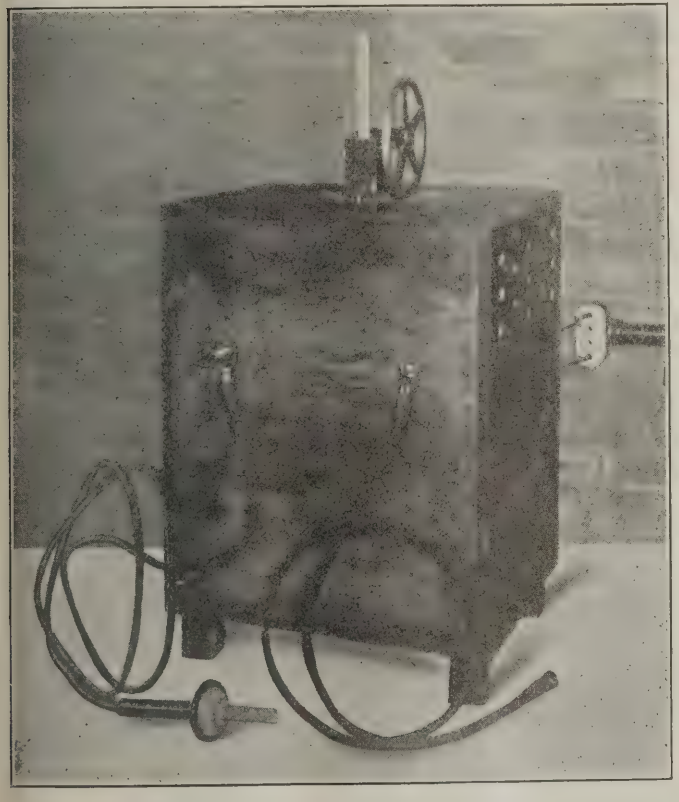
The Position of the Cutter Wheel on the Grinder

If a bolt is used it should be long enough to permit its being held in the hand during the process of sharpening. To sharpen, hold the cutter wheel against the side of a carborundum grinder in a position similar to that shown in the illustration, allowing the cutter wheel to revolve with the grinder. Both edges of the cutting wheel should be sharpened the same way.



A New Welding Transformer

The new Zeus arc welder, manufactured by the Gibb Instrument Company, Detroit, Mich., has been designed to overcome the disadvantages of bulk and moving parts which are inherent with all types of motor generator welding apparatus. The new welder consists of a simple transformer with no moving parts. The Zeus welder is comparatively small, making it unnecessary to set aside special space for its accommodation. It is built on the unit system,

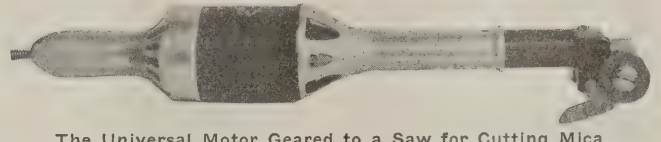


Welding Transformer Showing Hand Wheel Used to Secure Regulation

which makes it possible to connect a duplicate machine in parallel with the original when the work becomes too heavy for a single machine to handle. One of the outstanding features of the welder is its arrangement for regulation. It is not necessary to change any connection for the purpose of regulating the arc. A hand wheel is conveniently located on the top of the machine and furnishes a means whereby the secondary winding may be raised and lowered to provide for the regulation of course necessary for various conditions of work and sizes of electrodes. It is claimed by the manufacturer that the inherent reaction of the transformer automatically stabilizes the arc for different arc lengths and that the current consumption is from 20 to 40 per cent less than that for motor generator welding equipment. It is also claimed that, due to its inherent characteristics, the machine is particularly adaptable to overhead welding.

A New Commutator Slotter

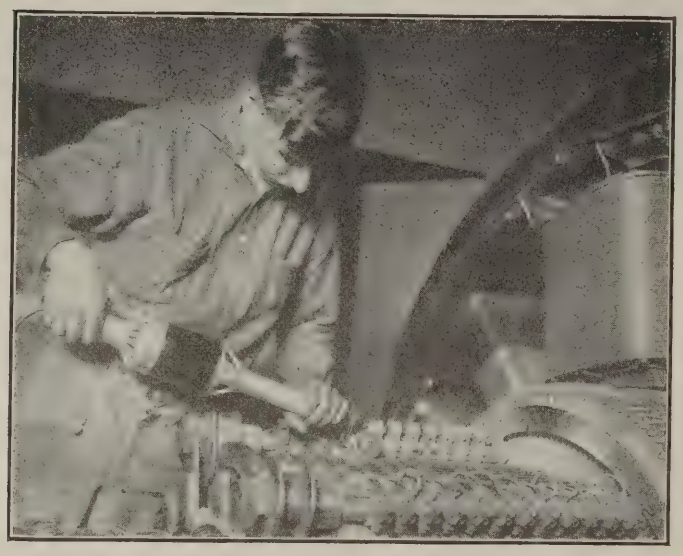
The practice of undercutting mica on the commutators of both large and small machines is quite generally followed by the leading manufacturers and users of such apparatus as the keeping of commutators free of high mica assists in preventing sparking, which burns and blackens the mica causing it to become still harder and more difficult for the carbon brushes to wear down. On the other hand high mica wears the brushes more rapidly. These conditions have brought about the development of a portable tool for undercutting mica. This machine, which is known as the Aurand commutator slotter is being placed on the market by J. H. Green & Co., Chicago.



The Universal Motor Geared to a Saw for Cutting Mica

It is a hand operated power-driven device, the essential points of which consist of a 1½ in. circular saw keyed to a hollow mandrel which in turn carries a worm gear. The hollow handle contains a steel driving shaft with a worm gear and small universal motor. Immediately behind the saw is a thin metal guide shoe which slides in the slot cut by the saw of the slotter, thus insuring a straight cut. Adjustments are provided so that the machine is serviceable for any size commutator and is arranged to cut the desired depth. The rate of speed at which mica can be cut with the device depends upon the length of the commutator, the grade of mica and the operator. It is claimed that on large machines from 20 to 30 in. per minute can be cut. Also the life of a saw depends upon the condition of the mica but should average approximately 150 ft. The total weight of the machine is about ten pounds which is borne by the adjustable depth shoe on one side and a small roller on the other.

The handle and motor casing are made of polished cast aluminum; the gear reduction allows the saw to be operated at a speed that will produce the desired results and prolong the life of the saw. A series wound universal type motor is furnished for either 110 or 220-volt



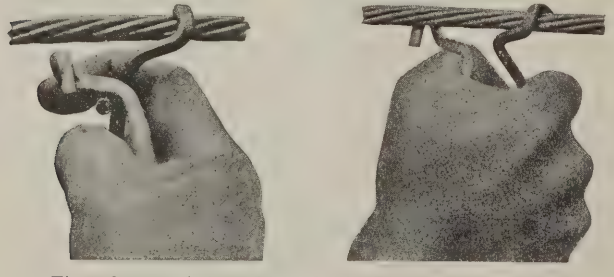
The Mica Undercutting Tool in Operation

d.c. a.c. service which when connected to the latter will operate at 25 to 60 cycles. In the handle of the device at the opposite end from the tool is a push switch for turning the current on or off.

A New Hand Placed Aerial Cable Ring

The Cameron Appliance Company, Everett, Mass., recently placed on the market a new aerial cable ring called the "Bonita." This new ring requires no tools to attach it to the messenger wire, as it is hand placed entirely, being attached to the messenger with one hand.

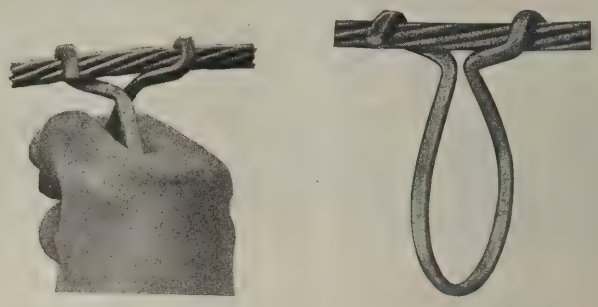
To attach the "Bonita" ring, place the right hand hooked end on the messenger, then squeeze the body



First Stage of Attaching Cable Ring to Messenger

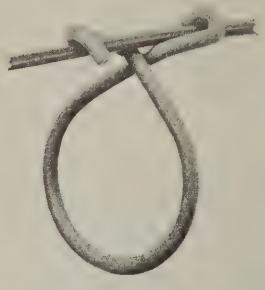
portion together and snap the left hand hooked end under and over the messenger as shown in the illustration. Due to the peculiar construction of the ring and the spring qualities of the material from which it is made, the rings are placed and removed with very little effort. It is claimed that "Bonita" rings have been attached to the messenger twice as rapidly as the old flat wire type, which requires pliers when applying them. It is also claimed that the "Bonita" ring does not slip or creep, and that in attaching the ring the zinc coating is not injured in the slightest degree, as is the case with tool-applied rings.

These rings are made in two types, "closed and



Second Stage of Attaching Cable Ring to Messenger

open." The closed type is for new work when the cable is pulled directly into the ring. The open type is used for old work or re-clipping or re-hooking existing cables. The open type of ring is formed with an extra large opening at the top of the ring, which permits the hook end to be passed over and around the cable and then attached to the stand in the regular way. The rings are coated with a heavy deposit of zinc after being formed on automatic machines. This coating is smoothly and uniformly applied to every part of the surface of the ring. They are made of semi-spring steel wire with a cross section of about ¼ in. by ⅛ in. with rounded edges, so that there is a broad flat surface for the cable to rest on. The formation of the hooks gives the ring its gripping power on the messenger.



Ring In Place

These rings are made to fit any size of strand and each size of hook, when formed, will take any two near sizes of strand, as, for example, ½ in. and 7/16 in., 7/16 in. and ⅜ in., ⅜ in. and 5/16 in., etc. This establishes a means of determining the size to use when the size of messenger is known. It is claimed that Bonita rings have a factor of safety of from 25 to 100 times the load they are called upon to carry, and are made in six cable sizes from 1½ in. to 4 by ½ in. increments. A 1¼-in. ring made out of round wire is also manufactured for small cables or twisted pair distribution.

Electric Heating Furnace

An electric tool-tempering furnace, which uses the barium chloride and salt principle, is proving highly successful in the South Philadelphia Works of the Westinghouse Electric & Mfg. Co. The chief advantages of this type of furnace over those using gas, coke, oil or wood, are constancy and ease of control of heat, cleanliness, equal heating of each atom of the specific part of the tool to be tempered, low cost of operation, and excellence of the finished work.

Fig. 1 illustrates the simple construction of the furnace. The outer shell, a cast iron cylinder, is about 3 feet high and 3½ feet in diameter, which is packed with fire brick

and occasionally a layer of asbestos. The circular reservoir in the center, which forms the operating part of the furnace, is 12 inches in diameter and 14 inches deep.

The heat is supplied by two pairs of electrodes, built in on opposite sides of the walls of the reservoir. The

Fig. 1—Electric Tool Tempering Furnace

electrodes operate on a 16 to 30 volt alternating current circuit which is controlled by the switchboard and transformer shown in Fig. 2. Carbon sticks are placed be-

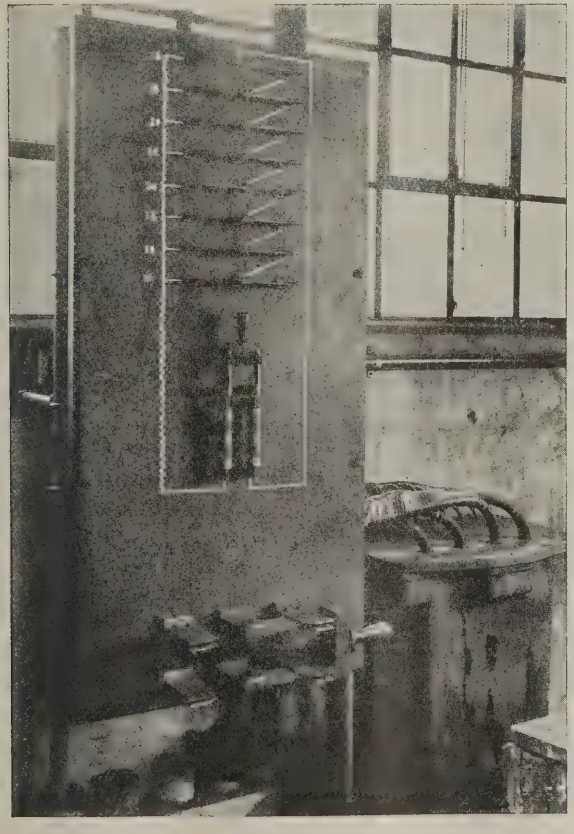


Fig. 2—Switchboard and Transformer Controlling 16 to 30 Volts Alternating Circuit on the Electric Tool Tempering Furnace

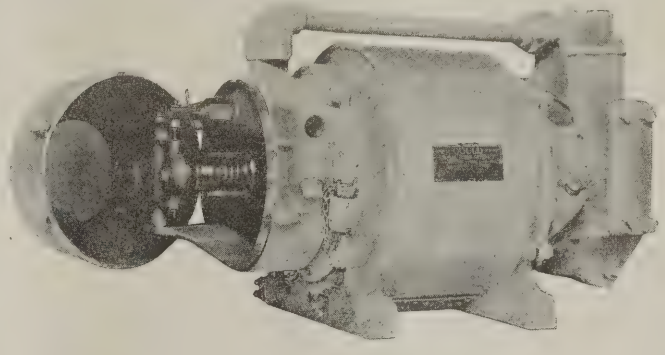
tween the electrodes in the reservoir to complete the circuit.

The current is started on the 30-volt circuit. Salt is fed into the reservoir and when it is melted it acts as a conductor and completes the circuit. The carbon sticks are taken out. A mixture of barium chloride and salt is then fed into the reservoir, the final proportion being about 60 per cent barium chloride.

When the temperature of the liquid reaches 1425 degrees Fahrenheit the voltage is lowered. The current regulation at the switchboard gives a quick and easy method of control so that the temperature of the liquid can be held at any predetermined degree of heat required for each specific tool.

The Gould Simplex Turbo-Generator

The Gould Coupler Company of New York is placing on the market a new 500 watt, 32 volt turbo-generator for locomotive headlights. The new generator is designed on an entirely different principle from any of the headlight equipments that have heretofore been marketed. It is an alternating current device and combines a number of advantages that are inherent with this type



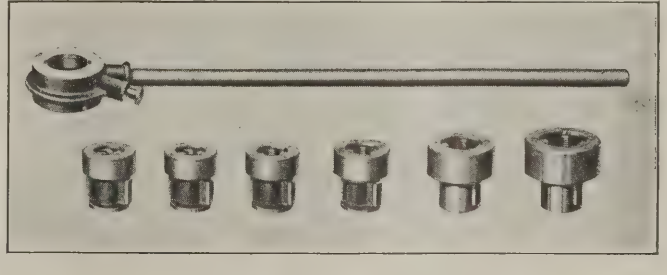
The New A. C. Headlight Generator.

of machine. There are no rotating wires, no commutator and no brush holders or brushes. The rotating element revolves in ball bearings. The new machine will be on exhibit at the conventions held at Atlantic City this month.

A more complete description of the outfit will appear in a later issue of the *Railway Electrical Engineer*.

Beaver Small Pipe Threader

A pipe-threading tool has recently been brought out by the Borden Company, Warren, Ohio, for small pipe sizes. The dies are built on the unit plan to thread ⅛-in., ¼-in., ⅜-in., ½-in., ¾-in. and 1-in. pipe. The set may be secured complete or the units may be purchased separately.



No. 3 Beaver, Jr., Pipe Threader

This tool, known as the No. 3 Beaver, Jr., consists of a ratchet handle and separate die heads to thread each size of pipe. The whole outfit is packed in a convenient wooden case. The ratchet mechanism is entirely encased so that it is dirt and grease proof.

General News Section

The Borden Company, manufacturers of Beaver Pipe Tools, has opened up a downtown office at Room 501, No. 549 West Washington Boulevard, Chicago, Ill. The new office will be in charge of Charles A. Greene.

The Okonite Co. has transferred its entire executive staff from New York to its plant at Passaic, N. J., where its main office will be located hereafter. A sales office will be retained at 501 Fifth Avenue, New York.

The Adapti Company, Cleveland, Ohio, manufacturers of Adapti boxes and wiring specialties, has changed the location of its Chicago branch office to 210 Madison Terminal Building, corner of South Clinton and Madison Avenues. J. H. Dutton is in charge of this office.

The Veteran Employees' Association of the Pittsburgh Division of the Pennsylvania Railroad held its annual reunion at Pittsburgh on May 16, with about 400 members in attendance. Among the enginemen present was Frederick Fleck, 90 years old, who entered the service of the railroad in 1854.

The Portland Cement Association opened a new district office in the Hubbell Building at Des Moines, Iowa, on April 1. L. R. MacKenzie is district engineer in charge. He has been identified with road work in the Middle West and on the Pacific Coast for 12 years, both as engineer and contractor.

At a Recent Meeting of the Institute of Electrical Engineers in London, the members had the pleasure of listening to a lecture by a British aviator who was at the time flying at an attitude of 3,000 ft. The talk given by the aviator described the flight from his position in the air. This is the latest airplane wireless sensation.

The Lehigh Valley has awarded a contract to the Roberts & Schaefer Co., Chicago, for the construction of a 750-ton capacity four track, automatic electric, reinforced concrete locomotive coaling plant and a 750-ton reinforced concrete sand-handling plant at Ashmore, Pa. The contract price is $75,000, and it is stated that installation will begin immediately.

The Manufacturing Facilities of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., are to be increased by the addition of several buildings. The plant space now covers about nine acres and consists of 22 buildings. Recently, two structures of brick and concrete were added. Contracts have been let and construction is already under way on the new buildings which will be of reinforced concrete and brick.

Regular Airplane Mail Service has been announced between Cleveland and Chicago, a distance of about 350 miles. Airplanes are to start from each city at 9:30 A. M., and will be scheduled to arrive at destination at 2 P. M. The Post Office Department plans to transfer mails to and from railroad mail cars at Cleveland, so as to give the benefit of the quick time to letters from Chicago to New York, Boston and other Eastern cities, and vice versa.

As a War Memorial to the more than 8,000 employees of the Westinghouse Electric & Manufacturing Company who have entered the service of the government in the war, the company has decided to establish four technical scholarships each year. Candidates will be limited to sons of employees of the Westinghouse Electric & Mfg. Company and its subsidiaries and to the younger employees of the company or its subsidiaries who have been in their service for a period of at least two years and who do not exceed the age of 23. The selection is to be determined by competitive examination, to be conducted annually by the company's educational department under direction of a committee composed of three vice-presidents of the company.

The Brotherhood of Railway Clerks, in convention at Cincinnati, has adopted resolutions in favor of the establishment of a union of all railroad workers; also one in favor of government ownership of railroads. The name of the organization has been changed so as to include express and steamship clerks, and it now reads, "The Brotherhood of Railway and Steamship Clerks, Freight Handlers, Express and Station House Employees." The convention voted to pay the grand president $10,000 a year; the grand secretary, $7,500; the grand vice-presidents, $4,000 each; organizers, $3,600 each; editor of *The Clerk*, $3,600. The salary of the grand president heretofore has been $3,500. Charles M. Owens, of Cincinnati, has been elected grand secretary. Walker D. Hines, Director General of Railroads, addressed the convention.

Electrification of Swedish Railway

The Swedish State Railway Administration has published a statement to the effect that after investigations regarding the electrification of the entire Swedish railway system, it has come to the conclusion that the plan can be carried out in 30 years at a cost of 192,000,000 kr. The advantages of electrification are that the whole of the power needed can be obtained from eight Swedish electric power stations, the traffic capacity will be considerably increased, and a great saving in staff costs will be effected. Sweden's enormous water power will, in the first place, be made available for this purpose.

Electrification on the Paris, Lyons & Mediterranean

The Paris, Lyons & Mediterranean Railway Company is proposing, subject to government sanction, to electrify the line between Clermont Ferrand and Nimes, via Alais. The distance is about 130 miles. The necessary power will be obtained by the construction, in the Department of the Lozere, of a barrage or dam near Florac,

closing up a small valley, so as to form a fresh-water lake of six miles in circumference. The lake will contain 45,000,000 cubic metres and the water will fall a distance of 500 ft. The cost of constructing the lake and power station is estimated at about $40,000,000.

New Electric Locomotive for the New Haven

The New Haven railroad has received and tested two large electric passenger locomotives of an order of five, to be used between New Haven and New York. These locomotives will be able to haul 12-car trains at high speeds. At present, passenger trains in the electric zone are limited to 11 cars.

The large new electric passenger locomotives are built to run on both routes by which the New Haven enters New York city, namely, over the New York Central line from Woodlawn to Grand Central terminal and over the New York connecting and Long Island railroads by the Hell Gate bridge and East River tunnels to Pennsylvania station.

To run over the above two roads and the New Haven, the locomotives are equipped to operate in three different ways—from the overhead trolley at 11,000 volts alternating while on the New Haven, from an under-running third rail at 660 volts direct, while on the New York Central, and from an over-running third rail at 660, while on the Pennsylvania.

In general design the locomotives are like the present 076 to 0111 class, but embody all modern improvements in electrical, mechanical and airbrake equipment, essential to insure safety and reliability of operation. Furthermore, they are 1½ times as powerful, so that they are capable of hauling 12 steel cars in fast express service. A speed of 70 miles per hour can be safely attained. The total weight is 172 tons. Motors, 12 in all, are geared and drive the wheels through helical springs. This type of locomotive is representative of what is recognized as the best practice in highspeed electrical locomotive design. It has proved to be the most successful of a number of radically different designs tried out in long periods in service.

From the preliminary trials already made, both officials and crews are delighted over the successful performance. Cab and trucks were built by the Baldwin locomotive works, electrical apparatus by the Westinghouse Electric and Manufacturing Company, and the airbrake apparatus by the Westinghouse Airbrake Company.

The New Haven officials in charge of the building were W. L. Bean, mechanical assistant to the federal manager: H. C. Qviatt, superintendent of motive power; A. L. Ralston, mechanical superintendent; and Messrs. Gibbs and Hill, consulting engineers.

Hydraulic Turbines for Niagara Falls

The two turbines being built by the Wellman-Seaver-Morgan Co., Cleveland, Ohio, for the above development will have a capacity of 52,500 hp. each, when operating at 187½ r.p.m. under a normal head of 305 ft.

The turbines will be of the single-runner vertical type, discharging downward into a single draft tube. The turbine casings will be of cast steel, of spiral form. The gates will be of the balanced wicket type, operated through suitable mechanism by a governor located on the generator floor.

The throat of the spiral casing leading to the runner will be spanned by a speed ring having ribs or vanes properly designed to direct the water to the turbine gates. The weight of the rotating turbine parts and the hydraulic thrust on top of the runner will be carried by a thrust bearing located on top of the generator.

All of the gate mechanism, except the gates themselves, will be outside of the water passages and accessible for adjustment and repair.

The runner will be approximately 10 ft. in diameter. The casing will have an inlet diameter of about 10 ft. and will discharge approximately 1,800 cu. ft. of water per second.

These turbines, when installed, will be by far the largest capacity hydraulic turbines in existence.

Electrical Energy From Crystals

At the last meeting of the New York Electrical Society, New York, May 26, A. M. Nicolson, of the Western Electric Company, showed how a sufficient amount of electrical energy to operate a number of telephones could be produced by applying variable stresses on a crystal of rochelle salts. Other kinds of crystals may be used for the purpose, but rochelle salt crystals are the most efficient of those which have been experimented with.

The method employed is a very simple one. It has been discovered that by applying pressure to two sides of a crystal, positive and negative charges of electricity will appear on the other sides of the crystal. Upon relieving the pressure these charges will be reversed. Reversals of torsion seem more effective than applying and relieving pressure for producing these charges.

Thus, for example, suppose that one end of a crystal is clamped rigidly in the place of a phonograph sound box, and that a phonograph needle is secured rigidly to the other end of the crystal. Then if pieces of tinfoil are applied to opposite sides of the crystal, a telephone receiver connected to these pieces of tinfoil, and the phonograph needle made to travel in the groove of a phonograph record in the ordinary manner, the impulses of electrical energy in the circuit will be an exact replica of the vibration of the needle and the music may be heard in the receiver. One crystal weighing about an ounce was used in this way to energize 160 telephone receivers.

This process may also be reversed. This was shown in a rather spectacular manner. A large crystal about three inches long was used for this purpose. Tinfoil electrodes were applied to either side of the crystal, cardboard discs placed on the ends and the whole given the appearance of a cylinder by connecting the two discs with a piece of paper pasted over them. This paper served the purpose of a sounding board. The two tinfoil electrodes were connected in an ordinary telephone circuit in place of the receiver.

Electrical energy applied in this manner causes the crystal to expand and contract slightly in time with the electrical impulses in the circuit.

This causes an increase and decrease of tension on the sides of the paper cylinder and produces an audible sound.

A man outside the room talked and whistled in to the

telephone transmitter, and the sound was reproduced on the paper cylinder with such accuracy and in sufficient volume that every one in the lecture room could hear and understand what was said.

Stone Franklin Company

The Stone Franklin Company has been organized to market the Stone Franklin car lighting system in the United States and Canada. This system was introduced into this country by the Franklin Railway Supply Company. The new company has elected the following officers: Joel S. Coffin, chairman of the board of directors; Ralph G. Coburn, president; C. E. Walker, vice-president; H. D. Rohman, chief engineer, and W. Truelove, secretary, with offices at 18 East Forty-first street, New York.

PERSONALS

J. M. SKINKLE, of the Western Electric Company, formerly connected with the engineering department, has been appointed assistant manager of the government department with headquarters at New York. J. A. PIZZINI, for a number of years sales manager at the New York office, has been appointed assistant manager at the same place. W. J. DRURY, until recently manager of the Western Electric Company's Cleveland house, has been appointed sales manager at New York, to succeed Mr. Pizzini. A. M. COLLINS, formerly sales manager at the Western Electric Company's Detroit office, succeeds Mr. Drury as manager of the Cleveland house. A. R. MAYNARD, until recently connected with the sales department in Chicago, has been appointed sales manager at Detroit, succeeding Mr. Collins.

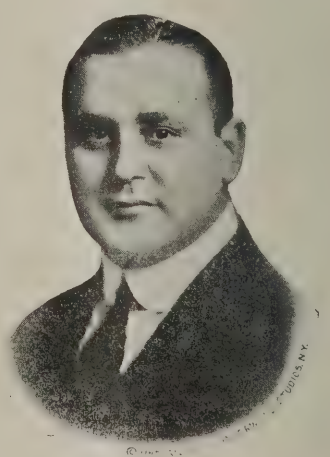
RALPH G. COBURN, president of the newly-organized Stone Franklin Company, has been identified with the Franklin Railway Supply Company. He was born at Boston in 1882, and graduated from Harvard in 1904. From 1904 to 1909 he was in the service of the American Glue Company, having charge of its western factories, with his headquarters at Des Moines, Ia., and Chicago. On May 1, 1909, he opened the Chicago office of the Franklin Railway Supply Company as resident sales manager. On June 1, 1911, he was made assistant to the vice-president, in charge of eastern-southern territory, with headquarters at New York. In December, 1913, he was appointed eastern sales manager of the Franklin Railway Supply Company, which position he held until his appointment with the Stone Franklin Company.

R. G. Coburn

CHARLES E. WALKER, vice-president of the Stone Franklin Company, has had a broad experience in industrial manufacturing, sales and railroad work both in this country and abroad. He is a graduate of the engineering course of the University College, of Bristol, England. He served as an apprentice with the Bristol Railway Carriage Company and as junior assistant on the staff of the Newcastle Electric Supply Company. He later went to South America on the mechanical constructional staff of the Buenos Ayres & Pacific Railroad. While in South America he joined J. Stone & Co., Ltd., as technical adviser and sales manager, with office in Buenos Ayres. In the latter part of 1912 he went to England to take charge of foreign sales in the main office at London. When war was declared he joined the British army and saw active service at the front for nearly three years. Receiving the order of the British Empire in February, 1917, he was returned to England to take charge of the manufacture of anti-submarine devices, which is the work he leaves to take up the position of vice-president of the Stone Franklin Company.

C. E. Walker

HARRY D. ROHMAN, chief engineer of the Stone Franklin Company, New York, is a graduate of the technical schools of Zurich, Switzerland. Upon graduation he entered the works of the Oerlikon Electrical Construction Company, and in 1903 qualified as an electrical engineer, with experience in high and low tension and a. c. and d. c. work, especially electrical traction. Later he entered the service of J. Stone & Co., London, and in 1910 was appointed chief of the testing and experimental departments. In 1914 he was appointed chief assistant electrical engineer, and held that position until October 1, 1915, when he entered the service of the Franklin Railway Supply Company as chief electrical engineer, which position he held at the time of his recent appointment. Mr. Rohman speaks several languages and has had an extensive experience in all European countries, as well as in South Africa and the Belgian Congo. He has a broad experience in car lighting engineering, obtained by many years of active work in that field.



H. D. Rohman

CALVERT TOWNLEY, assistant to the president of the Westinghouse Electric & Manufacturing Company, was elected president of the American Institute of Electrical Engineers at the annual business meeting of the institute held on May 16, in New York City. Mr. Townley graduated from Yale University in 1886 and later received the degree of mechanical engineer from that university. Immediately after graduating he joined the technical staff of the Westinghouse Electric & Manufacturing Company. The greater part of his work in connection with the technical staff has been on electric railway equipment. After securing an extensive experience in the company's works at Pittsburgh he was transferred to the Boston office in 1895. Nine years later he took charge of and consolidated for the New Haven, the electric railways which that company had recently purchased in Connecticut. After the formation of the consolidated company he was elected its vice-president. This position he resigned in the summer of 1911 to take up his present work.

Calvert Townley

EDWIN B. KATTE, chief engineer electric traction of the New York Central Railroad, was unanimously elected president of the New York Electrical Society for the ensuing year, at the annual meeting held on June 5.

Mr. Katte is a graduate of Sibley College, Cornell University, and has been connected with the New York Central Railroad in various executive capacities for the past 23 years.

He is a past vice-president of the American Society of Mechanical Engineers, Fellow of the American Institute of Electrical Engineers, member of the American Railway Association, member of the American Electric Railway Association, member of the American Railway Engineering Association, and other societies.

E. B. Katte

Mr. Katte has an exceptionally broad engineering experience and his election as president of the New York Electrical Society is a particularly happy one.

W. C. ENNIS, formerly superintendent of the Musselshell division of the Chicago, Milwaukee & St. Paul railway, has been appointed assistant superintendent of the Coast division, the Tacoma Eastern and the main line west of Othello. Mr. Ennis will work in conjunction with the electrical forces of the system, and will make an effort to hasten the electrification of the line from Othello to Seattle, so that it may be completed during the summer. The work of completing the substations is well under way; poles are set and wires are being strung. It is stated that the only obstacle to the operation of the line early in the fall will be a possible delay in delivery of the electric locomotives. Orders for the locomotives were placed some time ago.

P. C. GUNION has recently been appointed advertising manager, Industrial divisions, General Motors Corporation. This appointment was announced by D. Gleisen, chairman, Board of Managers, Industrial divisions, General Motors Corporation, and manager, Industrial Bearings division, Hyatt Roller Bearing Company.

GREGORY BROWN has been appointed manager of the Newark (N. J.) branch of the Western Electric Company to succeed Mr. Walker. Mr. Brown came with the company in 1905 as a member of the engineering department. He joined the General Telephone Sales organization in 1911 and became acting assistant manager of the Cincinnati office in 1914. In 1916 he came to the New York house as supply specialist, remaining there until his appointment as manager of the Newark office.

WALTER TREAT WALKER has been appointed manager of the Buffalo (N. Y.) office of the Western Electric Company. Mr. Walker came with the Western Electric Company in 1906 and in 1909 took charge of power apparatus sales in its New York office. During the war he served as First Lieutenant in the Signal Corps, U. S. A. On his discharge from the service he was appointed manager of the Newark (N. J.) office, in February, 1919, from which place he was transferred from his present position.

J. P. LEACH, foreman electrician of troop cars of the Pullman Company at Hoboken, N. J., has been appointed foreman electrician of that company with headquarters at Jacksonville, Fla., and G. R. SCHOMBERG, formerly foreman electrician at Chicago and recently returned from France with the United States Army engineers, has been appointed to succeed Mr. Leach at Hoboken, N. J. H. J. BARRETT, electrical repairman at Washington, D. C., has been appointed the night foreman electrician with headquarters at Philadelphia, Pa.

JOHN E. NORTHCUTT, electrical foreman of the St. Louis-San Francisco Railroad at Kansas City, Mo., has been appointed electrician, first class, with headquarters at Springfield, Mo., and CLARENCE J. THOMPSON, formerly of axle light maintainers, and lately returned from France, where he served 18 months with the 12th Engineers, has been appointed electrical foreman at Kansas City, succeeding Mr. Northcutt. ROBIN A. DEROSETT and FRED W. IRWIN, both of whom also served for 18 months in France with the 12th Engineers, have returned to the St. Louis-San Francisco. Mr. DeRosett was formerly foreman of axle light maintainers and has now been appointed electrical foreman at Memphis, Tenn., and Mr. Irwin has been appointed electrician, first class, at Kansas City, Mo., having been an axle light maintainer previous to his entering the service. MARION E. THOMP-

SON, who was also an axle light maintainer before going to France with the Signal Corps, where he served for a year and a half, has been appointed electrician, first class, with headquarters at Oklahoma City, Okla.

GRANT B. SMITH, who has been with the 18th Engineers since August, 1917, has returned from France and has been reinstated in his former position as electrician on the Northern Pacific Terminal of Oregon, with headquarters at Portland, Ore.

L. C. BOWES, formerly inspector of stationary plants, including electrical equipment, with the Chicago, Rock Island & Pacific railroad, and who has been in France with the United States Army, 108th Engineers, has returned to his old position.

EDWARD J. BURRIS has recently returned from France where he was engaged in work for the Ordnance Department. Mr. Burris was formerly a special apprentice in the electrical department of the Chicago, Rock Island & Pacific railroad at Chicago, and has re-entered the service of that road in the electrical department with headquarters at Silvis, Ill.

C. W. JOHNSON has been appointed assistant manager of works of the Westinghouse Electric & Manufacturing Company. After graduating from Ohio State University, Mr. Johnson entered the employ of the Steel Motor Company of Johnstown, Pa. A year later he became associated with the Bullock Electric Company, of Cincinnati, Ohio, and in 1904 was made superintendent of Allis-Chalmers-Bullock, Ltd., of Montreal, Can. In 1907 he entered the employ of the Westinghouse company, being appointed chief inspector of works, later being promoted to general superintendent, in which capacity he served until his recent appointment.

TRADE PUBLICATIONS

"Trumbull Cheer" has arrived for May with its usual line of anecdotes and stories. Some particularly good ones appear on pages 4 and 5.

U. S. Light and Heating Corporation, Niagara Falls, N. Y., is distributing its latest number of "Flashes." In addition to the regular line of news of the storage battery industry, two illustrations are shown of a new type of arc welding apparatus recently placed on the market by the company.

The Fafnir Bearing Company, New Britain, Conn., is distributing the May issue of its house-organ "The Dragon." This month's issue contains some interesting photographs of airplane activities as well as the concluding article of "Life in a Steel Mill." Of special interest is the distinctive insignia worn on the left shoulders of the members of the combat division of the A. E. F., printed in colors.

Humil Manufacturing Company, New York, is distributing a 12-page pamphlet illustrated in colors showing and describing a number of types of its electrical device for heating rivets. The pamphlet outlines the numerous advantages of heating rivets by electricity. An interesting table is included in the back part of the book showing the time required to heat rivets of different sizes by the several machines manufactured by the company.

The Ohio Brass Company, Mansfield, Ohio, in its house organ, The O-B Bulletin for March-April contains an interesting article entitled "What Makes a Good Trolley Hanger," giving cross sectional sketches of one of the trolley hangers manufactured by this company. The booklet also contains a goodly number of short but pointed paragraphs to stimulate personal ambition that are well worth reading.

Electric Arc Cutting & Welding Co., Newark, N. J., has recently issued an interesting illustrated and descriptive booklet in which are set forth the characteristics of the welding transformer manufactured by this company. Numerous photographs are shown illustrating the work accomplished by the machine. Among the claims made for the outfit are its low power consumption and ease of portability. A number of welding accessories furnished by the company are also illustrated and described.

Melting Metal with Electrically Heated Pots is the title of a new 6-page 3½ in. by 6 in. envelope folder which has just been published by The Cutler-Hammer Mfg. Co. of Milwaukee and New York. This folder calls attention to the advantages of electrically heated melting pots over gas and gasoline, on account of cleanliness, elimination of open flame, greater efficiency and ease of control. C-H electrically heated metal melting pots are made to melt down and maintain at the proper temperature all soft materials, such as lead, tin, solder, babbitt, etc. They are limited to a maximum temperature of 550 degrees Fahr., and are made in standard sizes up to 150 lbs. metal capacity. Two types are described in this new folder.

Crouse-Hines Company, Syracuse, N. Y., has issued Bulletin No. 304 on "Imperial Floodlight Projectors and Reflectors." This is a new publication taking the place of bulletin No. 303, and bringing up to date all of the information respecting this well-known line of floodlight projectors and reflectors. The new bulletin contains much additional information and, covering 64 pages, is most complete. The latter part of the bulletin is devoted to types RM and RS Imperial reflectors, which have been designed especially for use in lighting the stalls of locomotive roundhouses. A number of half tone and diagrammatical illustrations are shown of such installations, also views in which these reflectors are used for other railroad and dock service.

Sprague Electric Works of the General Electric Company has recently issued two bulletins. One of these bulletins, No. 48701-A, is devoted to the description and illustration of the Sprague electric dynamometer, a machine designed for measuring torque. The pamphlet shows photographs of various sizes of the machine and describes the methods of applying it in testing several types of gasoline engines. The second bulletin, No. 48713, illustrates and describes the Sprague electrical loop system for handling material. The system consists of a mono-rail carrier train, with tractors, and two trailer hoisting units, running on a curved track of a bridge which forms one end of the adjustable loop. The bridge is movable and the crane runs from the rail on the side of the building onto the bridge without any switching on the part of the operator.

Railway Electrical Engineer

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GEAR AND SHAFT DRIVE FOR AXLE GENERATORS

There is no need of telling a car lighting man that a generator belt is a constant source of trouble and expense. He knows, too, that the belt is the only way of transmitting power from the axle to the generator which heretofore has met all requirements. In years past a number of attempts were made to drive car lighting generators from the car axle without the use of belts. Flexible shaft drives and generators mounted directly on the axle were tried, but they failed to meet all requirements in that they lacked durability, that they were not easily applied or removed, or for some other reason.

Now, two manufacturers of car lighting equipment have each produced a gear and shaft drive, in the design of which they have profited by the experience of automobile manufacturers. On each the power is transmitted through a shaft, gears and a spring or springs for absorbing shock which might damage the gears. They have all the ear marks of something that is good and may easily become strong competitors of the belt drives.

ENGINEERING STANDARDS

With the constantly increasing number of applications of engineering practice to a multitude of diversified industries, the necessity of organizing some authoritative body capable of deciding what shall be adopted as standard has been daily becoming more urgent.

There is much reason to believe that the formation of the American Engineering Standards Association, which is described in detail on page 231 of this issue, will prove to be a step in the right direction, if indeed it does not develop ultimately into an entirely satisfactory solution of this evergrowing problem.

One familiar example of standard practice in the electrical field is the adoption of 110-volts and multiples thereof for lighting and power purposes. The benefits derived from the fixing of these standard voltages for commercial circuits has been of immense value in developing many efficient labor saving devices. Without a generally recognized standard voltage electrical apparatus could never have reached the universal use that it has today.

It is only a few years ago that alternating current frequencies were considerably more numerous than at present. Nothing was gained by a variety of frequencies, in fact, such a state of affairs resulted in the dissipation of the designers' abilities to such an extent that progress in the development of alternating current apparatus was undoubtedly retarded. This condition no longer prevails for now a frequency of sixty cycles is almost universally used for lighting and power, while twenty-five cycles have been found practical for heavy electric traction where alternating current is used.

The other engineering fields have also passed through the various stages of development and have arrived at corresponding standards. The necessity for standards is paramount and it is doubtful if any better method could be chosen for their adoption than through the mediation of the American Engineering Standards Association.

THE ELECTRIC HEADLIGHT SITUATION

The report of the Committee on Electric Headlights of the Association of Railway Electrical Engineers which was presented before the semi-annual convention of the association on June 23, and which was again read before the meeting of the Mechanical Section of the American Railroad Association on June 24, deals with a subject which is a particularly live one at the present time, because of the large number of locomotives that are being equipped with electric headlights. The first presentation of the report provoked a great deal of discussion and brought out many and diverse opinions as to just what should be considered standard practices in the various parts of the equipment. While the report of the committee indicates that it obtained its information from a large number of roads as to the practices that are being used, it is plainly evident that the time has not yet arrived to bring about the complete standardization of locomotive electric headlights. There are some parts of electric headlight equipments the standardization of which is not probable or advisable. There will eventually be standard practices adopted in some of the wiring, conduit, switches, turbo-generators, etc. Unquestionably the several roads will retain their own practices to a large extent. Although methods of installations cannot be generally agreed upon there are certain parts of the electric headlight equipment which can be made standard, such as the capacity of the generators, voltage of the lamps, kinds of wire to be used, as well as lamp fixtures. These parts can readily be made standard on all roads and have already been made so to a large extent. The actual necessity for standardization of methods of installation is not a paramount issue, however, since locomotives are seldom used on any other than their own lines and the equipment adopted by any one line will not conflict in any way with the practices of the other lines.

The report as submitted by the committee should not be considered as a final attempt at standardization, but rather as an outline which represents the main features

of present practices on a number of the largest roads and something which may be changed from time to time as necessity seems to dictate.

CONVENTION EXHIBITS

The magnitude and quality of the exhibition of railway appliances which accompanied the Atlantic City conventions last month stand out distinctively as the two factors which made this year's occasion such an unprecedented success.

The fact that three years have elapsed since the last exhibition was held is probably responsible for the large number of new devices shown. Many of these appliances were developed during the war and no opportunity was offered to make any general showing of them until the recent exhibition.

The demand for space so greatly exceeded the amount available that many companies were obliged to forego the privilege of exhibiting. Others, although unable to secure any space on the pier, located their apparatus along the boardwalk wherever possible.

One of the features of the exhibition this year, which largely increased the interest of the visitors, was that much of the apparatus could be seen in operation. Steam, compressed air and electricity were available for the use of the exhibitors, with the result that practically all of the appliances requiring power for their operation could be seen performing their regular functions. The vast array of moving machinery, presenting as it did a wonderful opportunity for comparison, was an education in itself.

The 1919 exhibition has set a high standard for future years, to be equaled and surpassed if possible. The road of progress leads ever upward, and fine as this year's exhibition was it is altogether reasonable to prophesy that subsequent exhibits may even improve upon the one recently concluded.

INFORMATION WANTED

During the past several years electrification has not progressed as rapidly as many of its advocates hoped it would. This has been due to a variety of causes, such as great improvements in steam locomotive design, extravagant claims of electrical equipment manufacturers, the war, etc., but the subject of electrification will not down and is constantly demanding more attention. Its consideration has been forced upon a few roads by terminal and trunk line congestion, and many more are considering it on a basis of ton-mile costs. The design of electric traction equipment is an exact science. An electric locomotive is essentially a constant speed machine; that is, it will operate under conditions of maximum load and maximum efficiency at a certain speed which may be predetermined, and if it is an alternating current machine it will operate at certain speeds, the values of which are practically independent of the load. It is possible to design an electric locomotive for hauling a train of a given weight over certain curves and grades and have the actual operation agree with the predetermined schedule within two or three per cent. This means better handling of traffic and a general tuning up of operating conditions. More freight can be hauled on a given piece of track and in addition there are many other points of advantage.

On the other hand, it is not possible to design flawless equipment or to predetermine what the cost of electric operation will be with the same accuracy that running schedules may be adhered to. Even a new type of steam locomotive must be thoroughly tried out before it can be considered dependable. In the same way it is necessary to give electric locomotives a thorough work-out, so that imperfections of design can be corrected. Outside of the United States electrification is being considered in Brazil, Chile, France, Belgium, England, Japan, Australia, Italy, Jamaica, Switzerland and Sweden. The operating men in these countries are desirous of obtaining any operating data that may be available. During the war no one felt it his privilege to give out any such information, and American railroad officers seem still to be wondering if the data belongs to them or not. When this question is decided they will be in a position to render a great service to operating officers in this country and abroad, who are considering electrification projects, by making public the operating results that have been obtained on steam lines already electrified.

DAYLIGHT SAVING SHOULD CONTINUE

Those opposed to the daylight saving plan which was in effect last summer and will continue effective until October 26, have done everything possible to have the measure repealed. Very shortly after the law was passed it was found that farmers were decidedly antagonistic to the measure. This spirit has grown until the rural population of the country is practically unanimous in declaring against the plan. On the other hand, the majority of the dwellers in the cities are strongly in favor of the continuation of the measure. Without doubt a very large percentage of the cities' population is actuated by no other motive than that the plan given an extra daylight hour of leisure. If this were the sole consideration no particular harm would result from the repeal of the bill, but it is not. The strongest allies of the farmers in their fight against the daylight saving plan are the commercial lighting companies. There is no question but that the plan cuts into their revenues by reduction in the sale of lighting current. There is, however, the other side of the matter which is certainly deserving of consideration. The amount of revenue which the lighting companies feel they are entitled to is the exact measure of the saving effected by the consumer.

Not only is the saving of importance to private consumers, but it applies also in many branches of the railroad field. Large shops are extensive users of lighting current, and who can say that the railroads should not be chary of their expenditures. It is immaterial whether the lighting current is supplied by a commercial company or by the railroads' own power plants, for in the final analysis the result is the same. Coal must be consumed to furnish electricity. This is an undeniable fact, and every ton of coal used in furnishing artificial illumination where daylight can be made to serve equally well is just one more ton wasted. Although our coal supply is exceedingly large there is no conceivable reason why it should be wasted. The subject is one which has much more to it than the mere consideration of the feelings of any particular class of people. The daylight saving plan was adopted for the purpose of conserving coal. Is there any more reason why we should waste the coal now?

Semi-Annual Convention of the A. R. E. E.

The Atlantic City Meeting At the Hotel Dennis On June 23 Was One of the Best the Association Has Ever Held

THE opening session of the semi-annual convention of the Association of Railway Electrical Engineers was called to order by J. E. Gardner, president, at ten o'clock on the morning of June 23. In his address Mr. Gardner briefly reviewed the circumstances under which the last meeting of the association was held at Chicago, calling attention to the spirit of determination which made that wartime convention such a success and urging the members to enter with whole heart and spirit into the present proceedings and endeavor to make the meeting a good one.

The report of the secretary-treasurer, Joseph A. Andreucetti, was brief. Mr. Andreucetti stated the purpose of the meeting was to hear and discuss the progress reports of the several committees and that aside from this no elaborate program has been prepared. The sound financial condition of the association was indicated from the fact that the sum of $2,376.50 was in the treasury and that there were no liabilities.

With a single exception, all of the papers read were merely progress reports. The exception was the report of the Committee on Electric Headlights, of which E. W. Jansen of the Illinois Central railroad is the chairman. Mr. Jansen read the report, which is given in full as follows:

Report of Committee on Electric Headlights

Your committee in submitting the following recommendations for standard practice for conduiting and wiring locomotive headlight equipment, having in mind the necessity of installing a conduit system that will insure good service and one that can readily be removed and applied with a minimum amount of labor, recognizing the fact that the installation is not permanent, as the engine may have to be stripped at any time to allow for repairs to the boiler, cab or other parts of the locomotive. It has been the object of the committee to arrange the conduit plan so that the conduits could be removed with the wiring intact so that it can be placed in suitable racks ready to be re-applied to the engine when the repairs have been completed. Inasmuch as installation of the conduit on the engine is usually the last thing to be done, the factor of time is an important element to be considered, the more simple system of wiring and less complicated the conduit plan, the more readily can the men who maintain and install same do their work. The item of expense is one that enters largely in the re-application of the conduit and wiring as well as the first cost of installation and your committee has tried to keep in mind the practicability of the installation from the maintainers' point of view.

Equipment

1.—Recommend that an incandescent electric headlight be adopted with a 500-watt turbo generator, capable of developing 32 volts with full load on at a steam pressure of 125 lb. Governor to regulate speed of turbine properly between steam ranges of 125 to 200 pounds.

2.—Recommend that manufacturers of electric headlight equipment adopt a universal standard size of ball bearing which will be interchangeable and can be purchased on the open market. (No. 305 ball bearing is recommended).

3.—Owing to the transfer of motive power to foreign territory, the method of mounting the turbo generator should be standardized to facilitate interchanging of equipment. Recommend that the spacing of bolt holes for mounting the turbo generators be the same on all makes of equipment, and that the thickness of the legs of the turbo generator be standard so that a standard size stud bolt can be used.

It is recommended the committee be authorized to meet with a committee of manufacturers of headlight equipment to decide on standard dimensions.

Installation and Location of Turbo Generator

4.—The turbo generator shall be located on top of boiler as near the cab as practicable with the dynamo end towards side of boiler equipped with conduit system (preferably the left or fireman's side of the locomotive). Where locomotive conditions will not permit location of the generator set at this point it is recommended that the turbo generator be located on the left side and longitudinally with boiler, the turbine end towards the locomotive cab and in a position as not to obstruct the vision of fireman. Under no conditions should the exhaust pipe of turbine be attached in any way to the cab. Where it is necessary to place the equipment forward of center or at front end of locomotive, a ¾-in. extra heavy pipe should be run under lagging next to toiler for steam supply (this to prevent steam condensation or freezing of this pipe in severe weather), recommend that turbo generator be secured to boiler with ⅞-in. stud bolts.

Piping for Steam Connections, Etc.

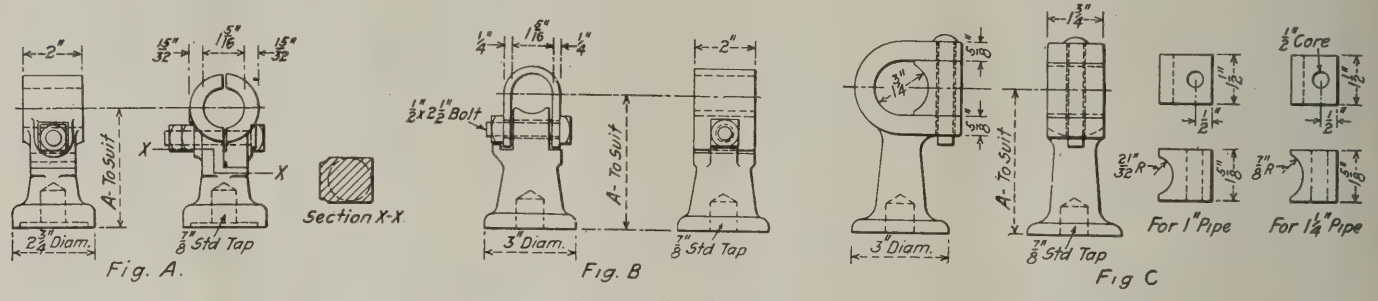
5.—The steam connection shall be not less than ½-in. extra heavy pipe carried from fountain in cab to turbine in such a manner that the line will drain from throttle valve to turbine. Where the pipe cannot be drained direct to turbine, the low point in line should be inside cab and a drain pipe placed with a suitable valve conveniently located so that engineer can open and drain steam line when turbine is not running (this to prevent the pipe freezing). Where the steam line is brought through the cab, a clearance of at least ½ in. should be maintained around pipe so that any movement of cab will not break pipe connections. Where the pipe passes through cab, the hole shall be closed with a weather proof cover that will allow for a free movement of the pipe.

Recommend that two valves be used in steam supply pipe, the one at manifold or source of steam supply and the other to be within easy reach of the engineer. Where this valve cannot be so placed, an extension handle should be used—removed from hot steam pipe so there will be no danger of engineer burning himself in turning the valve on or off.

Locomotive Wiring

6.—The conduit system and wiring for electric headlight equipment on locomotive boiler shall utilize the hand rail where possible. The wires from turbo generator set shall run to cab and to front end of locomotive in hand rail conduit (preferably on left or fireman's side). This hand rail shall be of standard galvanized electric conduit of not less than one inch inside diameter. (Figures A, B and C show three designs of suitable hand rail column, either of which is acceptable.)

The conduit shall be supported and secured to boiler by special hand rail columns, provided with a detachable part or cap to facilitate the removal of the hand rail conduit as a unit intact. This conduit shall in no case be less than four inches above the engine jacket and shall



Three designs of suitable hand rail column any of which is acceptable

have at least 2½ in. clearance over all pipes on engine boiler. A suitable weatherproof box with terminal block or disconnecting device should be located on front of cab where wire enters same, so that wires may be readily disconnected. The connection between hand rail conduit and junction box shall be a non-rigid connection (three-quarter inch flexible steel conduit with suitable fittings recommended). A suitable weatherproof fitting or terminal box shall be placed at end of hand rail conduit with non-rigid connections between the classification lamps and the headlight case. This flexible connection shall be of sufficient length to permit the opening of door

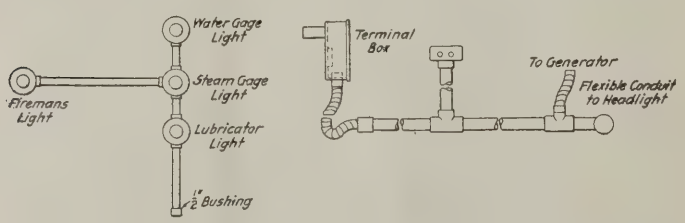


Fig. G-1—Arrangement of Conduit both interior and exterior

on front of boiler withaut necessitating the removal of headlight case. All conduit should be supported in a manner that will give at least 2 in. clearance above boiler and in no case shall the flexible conduit rest on the smoke box (this being unprotected with lagging is the hottest place on the locomotive boiler). The connection between terminal box and classification lamp should be so arranged that it can be easily disconnected either at the terminal box or at the lamp.

Cab Conduit

7.—The wiring in cab shall preferably be installed in one-half inch rigid steel conduit so applied that it may be removed intact (approved electrical fittings to be used throughout) (Fig. G1) and where conditions permit of such location the conduit fittings for drop cords to gage lights should be placed on ceiling of cab in front and not directly over boiler in order that they may be readily accessible. A detachable fitting should be provided for the water glass, lubricator, air and steam gage lights, to facilitate the renewal or repairs to drop cords in case of trouble (it is advisable to fuse each of these individual drops; armored cord or flexible steel conduit has not been satisfactory and is not recommended). No. 16 or No. 18 cotton covered lamp cord drawn through a ⅜-in. flexible asbestos tubing has proven the best for this service. Where this tubing is used the gage lamps and conduit fitting should be provided with a cover bushing or fitting having a half inch opening with a cupped recess, that will allow the tubing to pass through and form a knot in tubing so that the strain is taken on the tubing and not on the wire. This is formed in the tubing by turning in the ends of the cord—(see Fig. D). Where the gage lights do not come directly under the

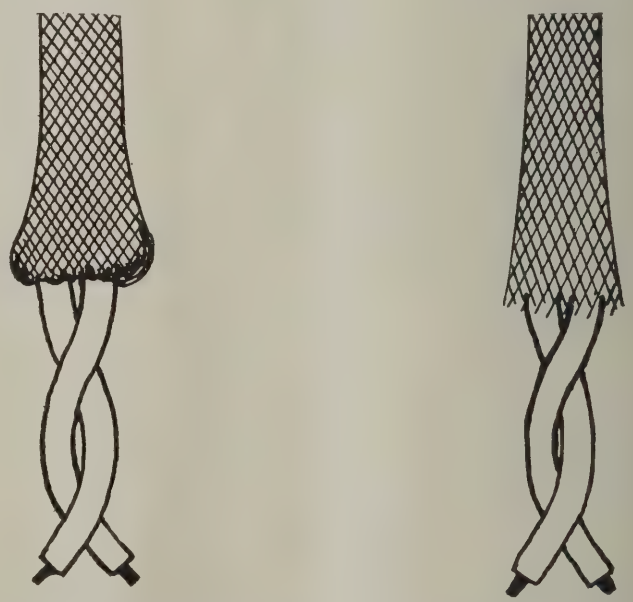


Fig. D.—Showing how end of loom may be tucked in to form a knot to prevent strain on the drop cord

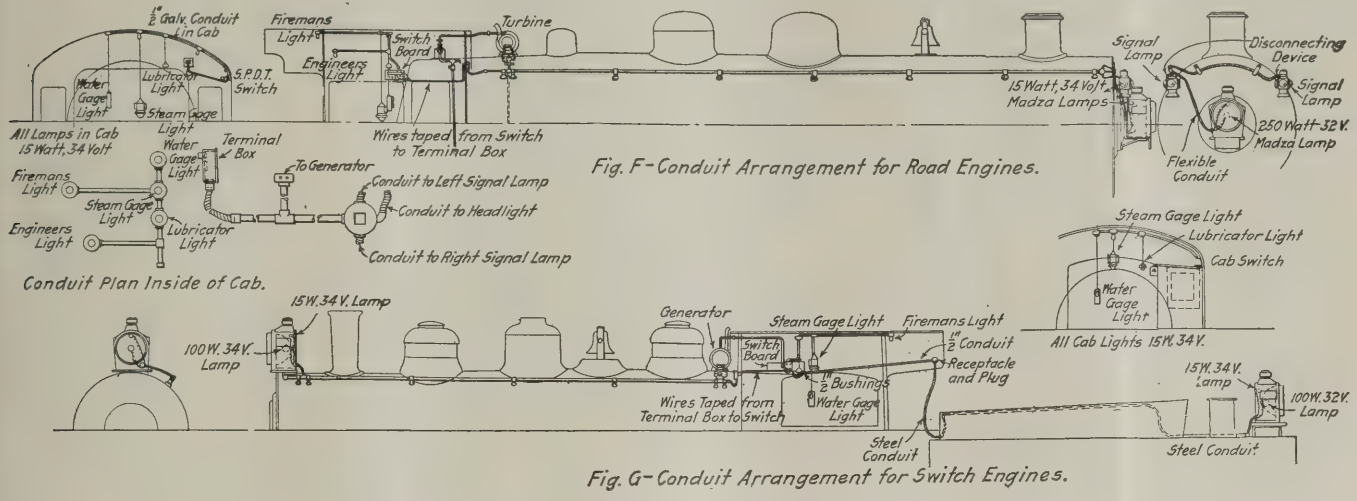
fittings, some provision should be made to loop back and secure the drop cord so that it does not come in contact with hot steam pipes or the head of boiler.

The conduit system in cab shall not be rigidly attached to the distributing center, neither should the conduit placed on the ceiling of cab be rigidly connected to conduit placed on sides of cab (the motion of cab having a

tendency to break the fittings or loosen the conduit). The distribution center shall consist of a single pole, double throw switch, a common wire terminal, resistance unit and Edison plug cutout all mounted on the same base, and placed on side of cab within easy reach of the engineer. The wires from the terminal box at front of cab to distribution center may be run in flexible conduit, loom, or back up service having front and rear headlights, shall consist of special single pole, double throw switch, common wire terminal and single branch two-plug Edison cutout, mounted on same base. (A four-position switch is recommended, wired as follows):

Off position—Blade at center.

First position—forward, front headlight full voltage.



Figs. F and G.—Conduit Arrangements for Road and Switch Engines

can be taped and cleated, but in no case shall it be a fixed part of the conduit system for the cab light circuits.

Open wiring for the cab lights (properly installed) is acceptable.

See proposed conduit plans Fig. F1—Road Engines, Fig. G—Switch Engines, Fig. E—Road Engines, in back up service.

Switch Board Panels

9.—The switchboard for road engines shall consist of a single pole double throw switch, one resistance unit, a common wire terminal and one single branch, two plug Edison cutout, all mounted on same base. The cab switch

Second position—forward, both headlights full voltage.

First position reverse or back, rear headlight full voltage.

Second position reverse or back, both headlights full voltage.

Where desired to dim headlights, the standard resistance unit can be cut in series with the center contact at switch blade. With a separate 10 ampere snap switch (or preferably a toggle switch) to short circuit and cut out this unit when not used. When desired to dim one or both of the headlights, this switch should be open or off and to impress full voltage on lamps the switch should

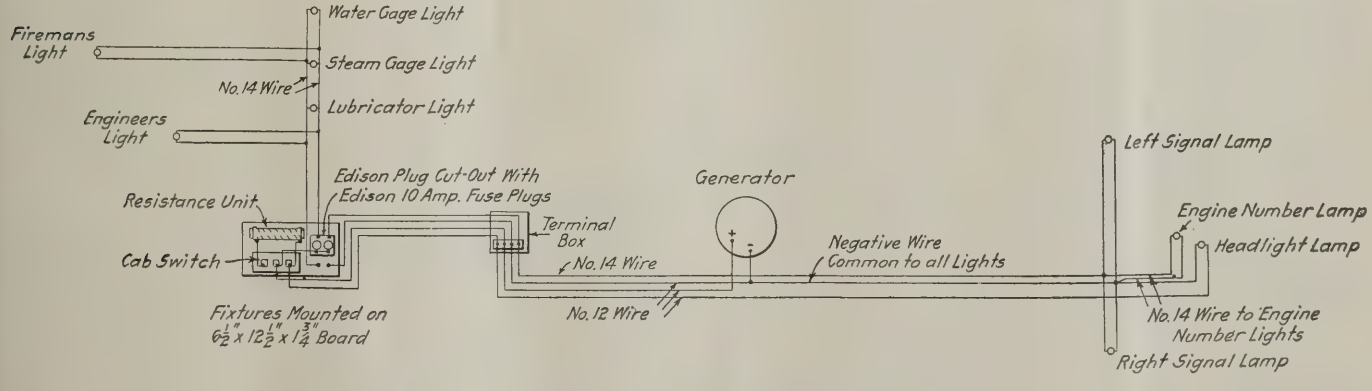


Fig. F-2.—Wiring Diagram for Road Engines

should be so connected that when blade of switch is in forward position full voltage is impressed on headlight lamp and when in opposite position dimming resistance is cut in headlight circuit. (See wiring diagram Fig. No. F. 2). One side of classificaiton and cab light circuits to be fused with 10 ampere Edison fuse plugs. Fusing of the main headlight circuit is not recommended.

10.—The switch board for engines in switching or be in normal position which is on or closed, headlight circuit not to be fused. (See wiring diagram Fig. G2.) The 100 watt headlight lamp should be placed forward of focal position in reflector so as to spread and not to throw a beam of light. It is recommended that a dimming resistance which will reduce the voltage of the headlight lamp approximately one-half be used. (A standard 3.12 ohm resistance unit 8 amp. capacity be

used with 250 watt 32 volt headlight lamp to comply with Interstate Commerce Commission ruling in this connection.) Do not recommend wiring for signal lamps on engines in switching service.

Road Engine in Back Up Service

Road engine in back up service having front and rear headlight, see wiring diagram, Fig. E.

Road engines having red signal lamps on rear of tender, see wiring diagram, Fig. H.

be made at the conduit junction box or at the lamp, which will readily permit of their removal, the connection to be weather-proof and not a part of the lamp supporting bracket.

Type of Wire

13.—The wire from generator to cab switch and to headlight lamp should be No. 12 AWG. The wire for cab lights, classification lamp or engine number lights may be No. 14 AWG. The use of standard rubber cov-

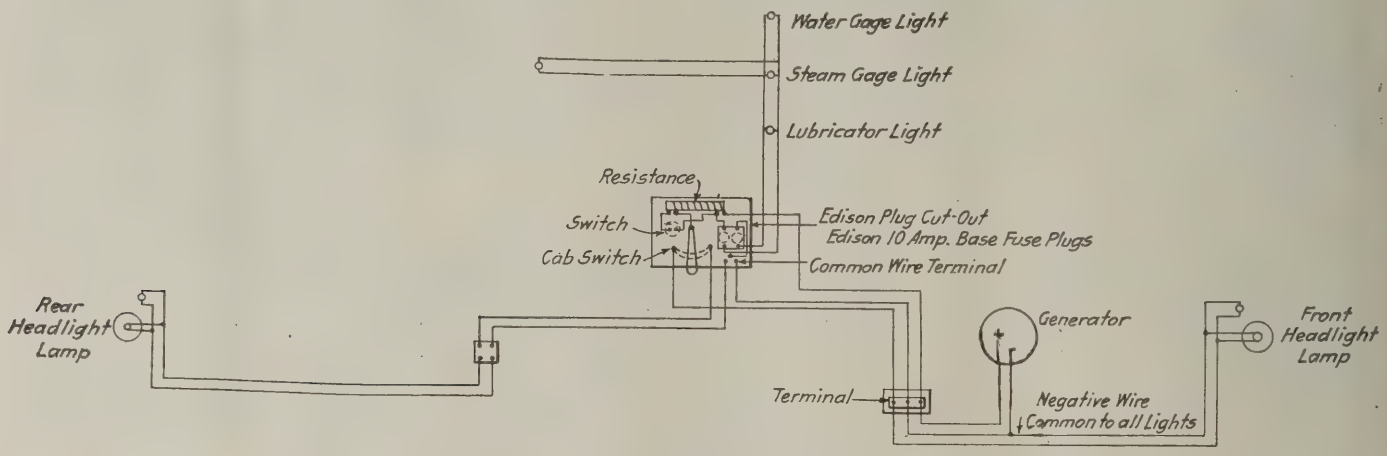


Fig. G-2.—Wiring Diagram for Switch Engines

Connection Between Engine and Tender

11.—Where headlight is placed on engine tender, a detachable, approved locking type of connector with flexible steel conduit connection should be made between engine tender and cab. (Recommend that this connection be made between roof of cab and the top of tender, leaving slack in flexible conduit to allow for swing of tender. This conduit to be carried back far enough to keep clear

ered and slow burning weather-proof wire has not proven satisfactory for resisting heat, moisture, oil and mechanical strains under conditions existing in locomotive service. A wire, therefore, with insulation that will not deteriorate nor adhere to the conduit at a temperature of not less than 225 degrees Fahrenheit and which will not be affected by oil, water nor mechanical strains, peculiar to locomotive service conditions within a period

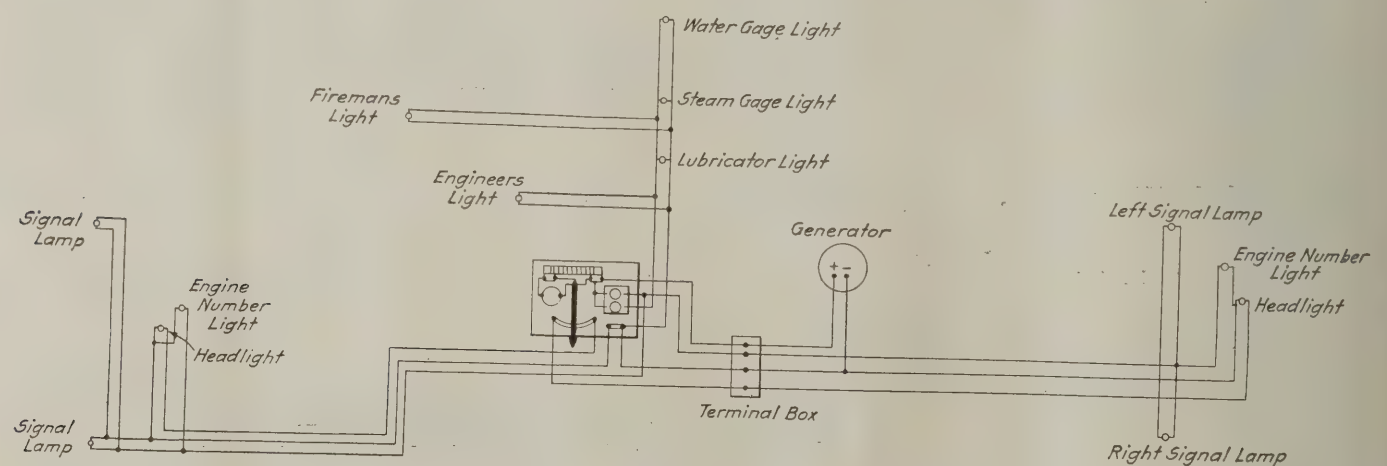


Fig. E.—Wiring Diagram for Road Engine having front and Rear Headlight

of gang way. The location of the connector and conduit under step of cab is not recommended on account of steam and water conditions.

Control of Classification Lamps

12.—A key socket should be used in each classification lamp to require enginemen to go to the lamp to light same, thus insuring that the lamps are burning. A switch in the cab for controlling these lamps is not recommended. The connections to classification lamps should

of five years, is recommended. Where stranded wire is used, lug terminals should be provided or the ends of wires soldered.

Lamps

14.—Recommend that a 15 watt S-17-34 volt special cab lamp be used in cabs, signal or engine number lights and all other outlets other than the headlight lamp.

Recommend that a 250 watt G-30-32 volt concentrated filament lamp be used for headlight on road engines.

Recommend that a 100 watt G-25-32 volt concentrated filament lamp be used on switch or back up service engines.

15.—Your committee recommends that a book of instructions on Maintenance of Electric Headlight Equipment be compiled for the guidance of headlight maintainers.

A sub-committee is now compiling this book of instructions.

Committee: E. W. JANSEN, I. C. R. R., chairman; L. C. HENSEL, Frisco Lines; GEO. E. MURRAY, Grand Trunk R. R.; J. A. ANDREUCETTI, C. & N. W. R. R.; GEO. B. COLGROVE, I. C. R. R.; H. R. PENNINGTON, C. R. I. & P. R. R.; C. WATSON, C. & O. R. R.; L. C. MUELHEIM, B. & O. R. R.

Discussion

Early in the discussion R. M. Newbold wished to know if the question of single wiring with single pole switches and grounded return had ever been considered in connection with locomotive headlights. He stated that this system was very successful on automobiles and could see no reason why it could not be applied to locomotives with equal success.

Mr. Jansen was of the opinion that this would not be possible on account of other mechanics working on the engine and felt that there would be much liability for the breakage of terminals.

Mr. Gardner drew attention to the fact that the locomotive headlight was of extreme importance and that much trouble might be caused by having one side grounded. He was of the opinion that it would be better with neither side grounded. Mr. Wanamaker, Rock Island Lines, made the statement that a very large per cent of their electrical troubles are mechanical and that most of these are due to grounds. He thought it might be of advantage to investigate this question and try to get better insulated wire. He also thought they might copy the automobile single wire system somewhat. In his experience, he stated, that more grounds developed on the 30-volt headlight system than on all of the other electrical service together. This, he thought, was due to the conditions of service and that it might be well to study for a better wire.

J. L. Minick (Penn.) stated that there were several matters which prevented single pole wiring. The first of these was the introduction of the electro-pneumatic brake system which he thought might possibly conflict. Also, that perhaps at some later day headlight equipment might be operated from car lighting batteries. Mr. Minick said that a good quality of cable must be used in headlight service and that at the present time several manufacturers were working on cables for this use.

He further stated that if it were necessary to depend upon rubber cables it might be advisable to stay away from the single pole wiring. He did not believe that they had progressed far enough to recommend standard practices. With regard to the matter of steam pressure Mr. Minick was of the opinion that this should be dropped slightly, perhaps to 100 lb. He was not certain that the size of the ball bearings recommended in the report was correct and he stated that the tendency of the manufacturers was to recommend ball bearings which were just large enough, and that he felt that No. 305 ball bearings was just about on the edge. With reference to bolt hole sizes, lugs, etc., Mr. Minick stated that he fully agreed with the committee and that in his opinion this was a matter which should have been taken up long ago. When the bolt holes are too close together, the equipment is top heavy. Mr. Minick asked why the hand rail should be on the fireman's side?

By placing this on the engineman's side he estimated that approximately 25 ft. of conduit and wiring could be saved. He recommended that the pipe to the steam dome be sufficiently heavy to withstand unusual strain. Mr. Minick stated he believed flexible conduit could be used in some parts of the exterior installation, but he was very decidedly opposed to the use of cast iron outlet boxes and recommended that pressed steel boxes should be used in all instances. He further stated that the hand rail should be made of the best possible material and that it should be installed in the best possible manner. He stated that 2,100 locomotives on the Pennsylvania had been equipped with rigid conduit systems and that about three-fourths of these have wooden cabs. Rigid conduit systems have been used in these cabs and so far no trouble has developed from their use, as the pressed steel fittings which are used are able to successfully withstand the strain without breaking. In his opinion open wiring adds to the fire hazard. Mr. Minick was not satisfied that terminal boards could be used in all cases and pointed out that their use in the cabs of the Pennsylvania locomotives would offer considerable obstruction. In briefly outlining the Pennsylvania Railroad's practice he stated that no fuses or switches were used in circuits where lights burned all the time and that knife switches

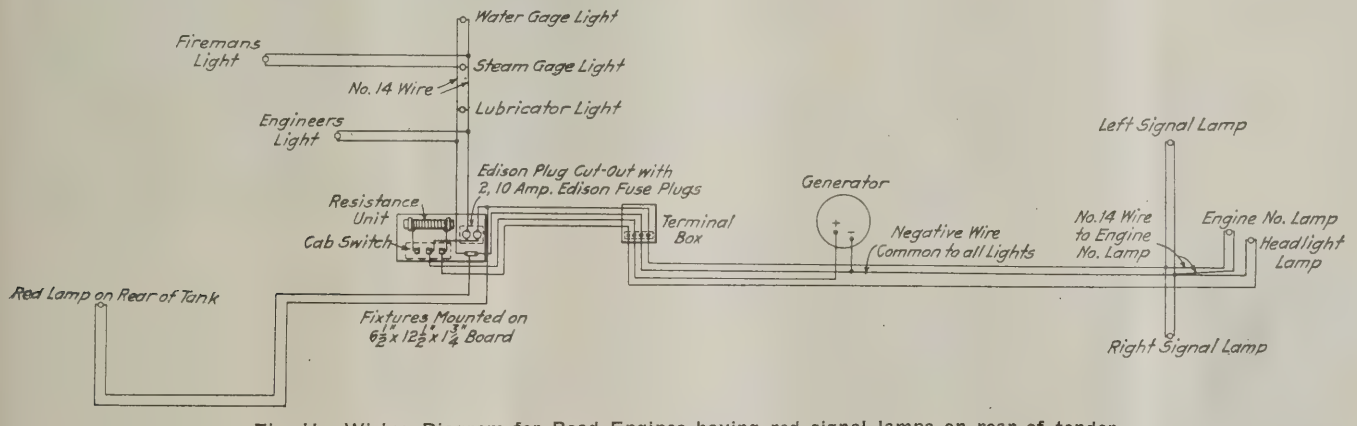
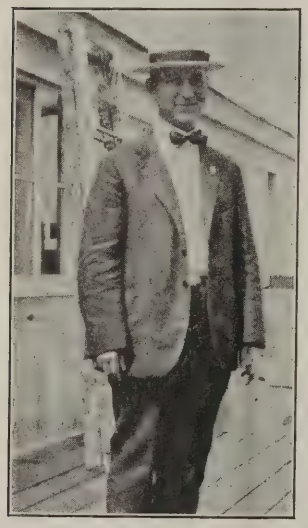


Fig. H.—Wiring Diagram for Road Engines having red signal lamps on rear of tender

were not used at all. There are three switches in the cab, one for the reading lamp, one for the headlight, and a third to short circuit the dimmer resistance. Key sockets are not considered altogether desirable. In describing a test made with 250-watt lamps Mr. Minick recounted the following facts: Three 250-watt lamps made by three different manufacturers were used in the test and the candle power varied considerably. This was apparently due to the character of the filament in the lamps. In one instance a man could be seen at a distance of 800 ft.; one month later with the same equipment and the same observers it was possible to discern a man on the track at a distance of 1,200 ft.; while a third test with the same equipment, the same observers, the distance at which a man could be seen was 3,000 ft. In concluding his remarks Mr. Minick stated that he believed the determining feature in a lamp should be its candle power rather than the size of a lamp or the distance at which a man, or any other object, could be seen.

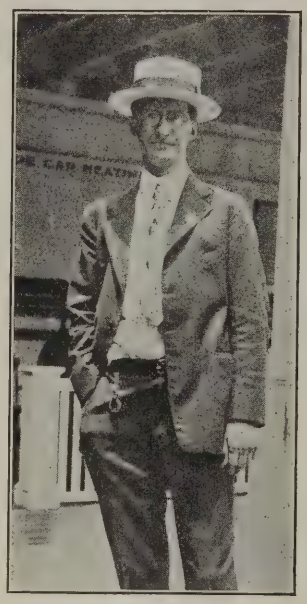
Mr. Jansen stated that the reason for the adoption of the 250-watt lamps was the desire to meet the government requirements. As to steam pressure he thought the value stated in the report was quite low and that they did not want to increase the range of pressure so great that the manufacturers would have difficulty in designing their equipment to cover a wide range. He also thought that three feet or lugs on the generator was desirable. With reference to the hand rail Mr. Jansen stated that the recommendations should be considered as tentative but not final. He also stated that the left side of the engine was chosen for the hand rail because the generator would be located on the left side in both cases, but he admitted that conditions would vary considerably. With reference to the drop lamps in the cab, he stated that a great many roads had tried flexible conduit and had found considerable trouble with it. Many experiences prove that ordinary lamp cord in asbestos tubing is desirable. He felt that properly employed the conduit system would work out very well, and with reference to terminal boards be considered them a ready and quick means of locating trouble. Mr. Jansen stated that the report of the committee was based on a questionnaire which had been sent out to 35 roads, 21 of which had answered. Most of the roads seem to favor circular loom or asbestos tubing for their drop lights.



J. L. Minick

Mr. Minick suggested that the committee meet with a committee of headlight manufacturers in order to have things standardized as much as possible. He also drew attention to the fact that wrecking cranes usually operated on a lower steam pressure than that specified, but he thought that this condition might be helped by increasing the size of the turbine nozzle.

C. P. McGinness, of the Pyle-National Company, stated that one type of their turbos would work very well above 100 lb. and that if the wrecking crane's pressure never fell below this value there would be no necessity for making any change in the nozzle and that between 100 lb. and 75 lb. a constant flow of steam would be had that would take care of the lighting. He stated that the reason 125 lb. was used was on account of the amount of water carried in the steam below this pressure. The value of 125 lb. was used as a safety margin. Mr. McGinness seemed to be of the opinion that since headlights have been in service so long that it would seem that there was something to aim at even though the time was not ripe to recommend definite practices. He thought that by this time some conclusions should be reached, although he admitted that these would probably be changed from year to year. The main thing was to separate the ideals from the ideas in locomotive headlight practice. He also stated that the steam drain was just as important as the steam pipe and that very frequently in cold weather trouble is encountered from the freezing of the drain pipes. If the end of this pipe is so located that it will be against a warm surface it will be easily possible to keep the pipe open and no trouble will be experienced. Mr. McGinness stated that the reason why extra heavy pipe was necessary was on account of the poor quality of steel pipes now used. In connection with the wire he stated that with slow burning wire the weather-proofing should be next to the wire and the outer surface polished.



J. E. Gardner

J. R. Sloan (Penn.) said that he thought that the report was good work, but not suitable to put in the proceedings of the association in its present form.

E. Wanamaker (Rock Island) called attention to the fact that they should not forget the Master Mechanics' Association, which had already accepted this report, and that as long as it was to act as a guidance it should be let go at that and in fact he was in favor of letting this report stand as recommended practice of the association.

Mr. Minick stated that he did not understand that the report was to be acted upon in any way by the Master Mechanics' convention, but that it was simply incorporated with their other reports as to what was recommended present practices.

Mr. Sloan stated that his idea was simply that the committee had had many viewpoints given and that they could now get busy and improve the report considerably.

Mr. Gardner said that he thought the committee could gather more information and make the final report in the fall meeting of the association.

L. S. Billau (B. & O.) stated that in his opinion practices will change very rapidly in the next few years and that the committee will be expected to change details

from time to time; also that other phases of the subject would be added.

Mr. Jansen stated in referring to the report that it was intended only as a tentative report as the practices would be very likely to change.

Mr. Andreucetti called attention to the fact that the report had been presented at the last annual convention and at that time much difference of opinion was shown. At that meeting various opinions had been discussed, it was found that the report could not be received as offered. Later on the questionnaire was sent out and it was felt that the best practices could be determined from

From Left to Right, J. E. Gardner, A. E. Voight, E. Wanamaker, and L. S. Billau

it. While this was going on the chairman of the A. R. A. asked for information on this subject. Under these conditions Mr. Audreucetti thought that the association should recommend the passing of the report representing present practices.

George Murray (Grand Trunk Western Lines) stated that he believed that one of the main things to be discussed was the type of lamp to be used and that he thought the 250-watt lamp was decided upon because it was the only lamp on the market. He stated, however, he knew that on switch engines several types of lamps had been used.

Mr. Billau said that the lamp was one of the most important features and that there was need for a headlight lamp for switching locomotives that would meet the conditions of this service. He also stated that a light frosting of the bulb might be necessary where a wide diffusion was desired. He believed that the tungsten lamp was not sufficiently rugged and that the subject was one which should be gone into with the manufacturers to see what could be done in the way of developing a suitable lamp.

Mr. Wanamaker stated that one of the men on the Rock Island Lines had patented a diffusion glass. He also said that they had equipped their engines with as many as ten different devices for reducing the glare of the headlights on switch engines and that the switchmen approved of these devices. He said that they were practically trying everything possible in order to prevent accidents.

Mr. Andreucetti said that he believed that they should receive the report as it stood, but that the work should be continued and a more complete report presented at the next meeting in October. This suggestion was made in the form of a motion to which an amendment was made by Mr. Wanamaker to the effect that the report should be considered as temporary and that the committee should be enlarged and go deeper into the subject, adding anything that might be of importance. With this amendment added, the motion was voted upon and carried. The meeting then adjoined until the afternoon session.

Brief Sketch of Progress Reports

The first report presented at the afternoon session was the progress report of the Electric Headlight Handbook Committee. It is the thought of this committee to prepare a handbook similar in all respects to the Car Lighting Handbook which was compiled last year and which so satisfactorily filled the requirements in the maintenance of car lighting apparatus. Special emphasis was placed upon the importance of preparing the headlight handbook, so as to include complete information concerning the theoretical operation of the various equipments.

The work of the Committee on Illumination was as-

Jos. A. Andreucetti and E. W. Jansen

signed to three sub-committees, namely, Sub-committee "A," car illumination; Sub-committee "B," on shop illumination, and lighting, etc., and Sub-committee "C," on lamp specifications. In answer to the question as to what might be expected in the way of increased efficiency of lamps, L. S. Billau seemed to be of the opinion that there was little to be expected in the way of reducing current consumption by increased efficiency of lighting units, as the tendency at the present is toward increased use of lamps with a corresponding increase of current.

E. Lunn, of the Pullman Company, thought that some

attention should be given to the artistic design of the lighting fixtures and that this question was at present under consideration by the Pullman Company.

In the matter of lamps for use on extension cords in shops, the practice of using carbon filament lamps, while desirable in view of its more rugged construction, will probably be eventually supplanted by tungsten lamps, due to the difficulty of securing a good grade of carbon lamps. It was suggested by J. L. Minick that auto transformers might be used on 110-volt circuits, and by this means reduce the voltage on the lamps to 32 volts. Tungsten lamps of much larger filament can be used with the corresponding rugged construction. The more general opinion of the members, however, was that the matter should be taken up with the lamp manufacturers, with the idea of getting them to develop a tungsten lamp that would be sufficiently rugged to withstand use on extension cords.

The Committee on Electric Arc Welding in its progress report expressed the intention of going into the matter of arc welding in a most thorough manner, insofar as the matter is applicable to the repair of locomotive

A. E. Voigt and E. Wanamaker

parts and in the numerous other fields on the railroad where welding can be carried on to advantage.

E. Wanamaker read the report of the Committee on Electrification. The committee expressed its desire to secure from as many of the members as possible all the information on this subject that is available. There is undoubtedly an increasing interest being taken by railroad managements in electrification projects, and it is information along this line that the committee wishes to be in a position to supply those roads that are logically interested in electric traction.

L. S. Billau read the report of the Committee on Train Lighting Equipment and Practice. This report covered a number of temperature rating specifications with reference to axle generators. These specifications represent the first steps in the standardizing of the ratings of axle generator equipment, and it is hoped that future specifications may be extended to include all parts of axle generator apparatus which may be properly assigned specified ratings.

The Committee on Compiling Costs for Maintenance of Head Light Equipment expressed its intention of seeking the assistance of the various roads as to their present methods of keeping cost records for maintenance.

Railroads Represented.

Atchison, Topeka & Santa Fe.—A. E. Voigt.

Baltimore & Ohio.—L. A. Billau, C. P. Bomfield, W. A. Camden, W. W. Leonard.

Central of Georgia.—D. C. Wilson.

Chicago & North Western.—J. A. Andreucetti, H. F. Barfoot.

Chicago, Burlington & Quincy.—J. E. Gardner.

Chicago, Milwaukee & St. Paul.—H. K. Fox.

Chicago, Rock Island & Pacific.—E. Wanamaker.

Florida East Coast.—Z. J. Zeigler.

Grand Trunk.—G. E. Murray.

Illinois Central.—E. W. Jansen.

Long Island.—R. W. Brodmann.

Michigan Central.—F. J. Hill.

Missouri Pacific.—L. D. Moore.

New York Central.—A. McGary, H. C. Meloy, H. W. Pinkerton.

New York, New Haven & Hartford.—P. G. Rush, F. Zimkowski.

Oregon Short Line.—C. P. Kahler.

Pennsylvania.—R. H. Elliott, E. E. Godard, W. C. Kershaw, J. L. Marsh, D. B. Pastorius, J. R. Sloan, D. G. Thwaites.

Philadelphia & Reading.—H. A. Stofflet.

Pullman Company.—E. T. Lunn.

Supply Companies Represented.

Central Electric Company.—R. N. Baker, A. L. McNeill.

Crouse-Hinds Company.—C. H. Bissell, F. J. Fancher, E. G. Smith.

Dodge Sales & Engineering Company.—N. G. Stark.

Electric Storage Battery Company.—T. L. Mount.

Electro Dynamic Company.—D. N. Balderston.

Gould Coupler Company.—W. F. Bouche.

Hazard Manufacturing Company.—L. W. Allen, C. P. Brodheim, T. A. Keefe, H. B. Pflasterer.

W. M. Lalor.—W. M. Lalor.

Okonite Company.—J. W. Hackett, J. L. Phillip.

Oliver Electric & Manufacturing Company.—J. A. Amos.

Pyle-National Company.—J. E. Kilker, C. McGinnis.

Safety Car Heating & Lighting Company.—J. L. Marsh and W. T. Manogue.

Schroeder Headlight & Generator Company.—J. Henry Schroeder.

Simmons-Boardman Publishing Company (Railway Electrical Engineer").—C. J. Corse, F. J. Fischer.

U. S. Light & Heat Corporation.—W. E. Brewster, W. L. Bliss, O. R. Hilderbrant, H. A. Matthews, G. P. Wray.

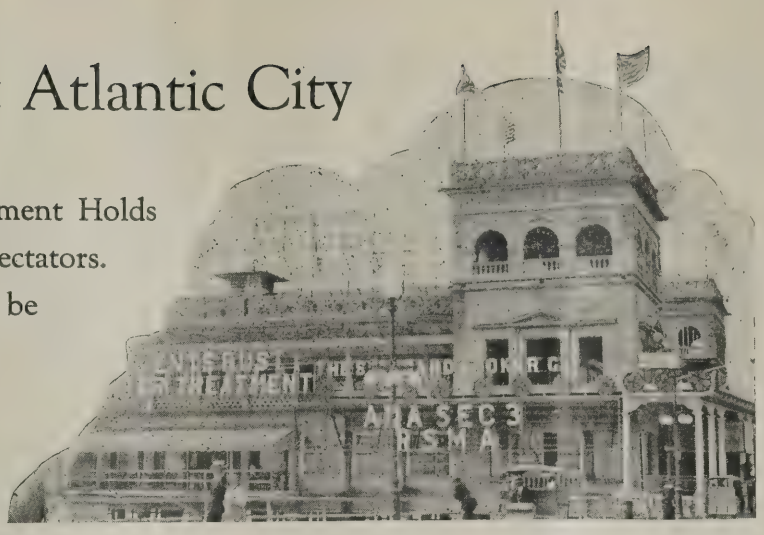
U. S. Rubber Company.—F. E. Dodson, P. B. L'Hommedeau, L. S. Hungerford, W. Weiss.

Miscellaneous.—R. M. Newbold of Washington, D. C.

"To Be an American is not to be the embodiment of conceit as to all things that are fundamental in America, or to be satisfied with things as they are or to let things drift."—*Franklin K. Lane.*

R. S. M. A. Exhibit at Atlantic City

Tremendous Collection of Railway Equipment Holds the Interest of Large Crowds of Spectators. Exhibition Unanimously Voted to be the Biggest and Best of Its Kind Ever Presented



NEVER before was there such a colossal exhibition of electrical and mechanical apparatus gathered together by the Railway Supply Manufacturers' Association as was presented to the immense throng of enthusiastic visitors last month on Young's Million Dollar Pier at Atlantic City.

So extensive was the exhibition that it touched practically every department of the railroad field. To have had an opportunity to view such an immense array of equipment was a liberal education in itself. One feature that went far toward attracting and holding the interest of the thousands of visitors who daily come to the pier, was that the machinery could be seen in operation. Electric power, steam and compressed air were available and those exhibitors whose devices required any of these power sources to satisfactorily demonstrate the qualities of their machines, made the most of the opportunity. It is probable that this one fact alone was very largely responsible for the many remarks of praise and commendation that could be heard everywhere. Everywhere one was more than satisfied with the exhibits for very few, if any, had expected to see anything like such a vast array of railroad appliances.

Some idea of the extent of the exhibiton can be had from the fact that there were 301 exhibitors occupying 93,467 ft. of space. Every available foot of floor space was pressed into service and there were many companies who had intended to exhibit their products, but who could not be accommodated. Some of the companies were able to secure space along the boardwalk.

The exhibits which were of special interest to the visiting electrical men are listed as follows:

American Car & Foundry Company, Berwick, Pa.—In addition to the various mechanical parts of locomotives and cars, the company demonstrated an electric rivet heater, with a capacity for heating four rivets simultaneously. The device is constructed on the transformer principle with an exceedingly heavy secondary winding. Represented by Clark D. Eaton, Scott H. Blewett, J. M. Keller and M. H. Connelly.

Baker, R. & L., Company, Cleveland, Ohio.—Type QTQ Baker electric industrial tractor; type DUQ Baker electric utility truck. Represented by George L. Weiss, Harry B. Greig, J. Harry Killius and Nathaniel Platt.

Brewster Company, Inc., William, New York, N. Y.—Bond bits; high speed twist drills, reamers and countersinks; high speed milling and gear cutters and hobs; etchograph electric marking machine; Bull Dog demagnetizer; electro lead burn. Represented by William Brewster, William E. McCabe and Frederic B. Squires.

Buda Company, The, Chicago, Ill.—Buda-Ross model G. W. electric headlight. Represented by Mark A. Ross, H. P. Bayley and W. F. Davis.

Clark Tructractor Company, Chicago, Ill.—Clark tructators for industrial and railway freight house and platform transportation and haulage. Represented by Robert A. Shiverick and Warren B. Eldred.

Consolidated Car-Heating Company, Albany, N. H.—Locomotive steam heat exhibit; Thermostat exhibit panel; door engine; electric cab heaters; air heaters; truss plank and panel electric heaters; switches; quick opening end valves. Represented by C. S. Hawley, W. S. Hammond, L. P. Hynes and G. E. Oakley.

Dressel Railway Lamp Works, The, New York, N. Y.—Electric headlights; classification lamps; gage lamps; lanterns. Represented by F. W. Dressel, F. W. L. Dressel, H. L. Hoskinson, B. P. Claiborne and J. C. Snyder.

Edison Storage Battery Company, Orange, N. J.—Edison alkaline storage battery for railway train lighting, railway signaling; industrial trucks and tractors; commercial vehicle and delivery wagons; storage battery locomotives; mine lamps; meter testing; manhole lighting; ignition and lighting. Represented by W. F. Bauer, H. W. Stortz and E. T. Sawyer.

Electric Arc Cutting & Welding Company, Newark, N. J.—Welders; hoods; electrode handles; electrodes. Represented by W. J. Murray.

Electric Controller & Manufacturing Company, The, Cleveland, Ohio.—Automatic controlling device for both direct current and alternating current motors. Represented by R. G. Widdows, M. D. Goodman, H. K. Hardcastle and A. A. Piper.

Electric Service Supplies Company, Philadelphia, Pa.—Keystone turbo-generator; Keystone locomotive headlight switch; "Golden Glow" locomotive headlight. Represented by L. A. Darling, A. H. Englund, C. J. Mayer, J. R. McFarlin, E. E. Hedler, J. W. Porter and W. J. Bryan.

Electric Storage Battery Company, The, Philadelphia, Pa.—E. S. B. constant voltage axle light system in operation with "Chloride Accumulator." Storage batteries for industrial trucks and railway signal service.

Represented by J. Lester Woodbridge, F. G. Beetem, T. L. Mount and H. E. Hunt.

Electro Dynamic Company, Bayonne, N. J.—One complete A. C. motor; 1 complete D. C. motor; 1 A. C. motor; 1 A. C. stator without windings; 2 compensators; 1 lamp regulator; 1 field or general regulator; 3 15-inch battery connectors; 3 48-inch battery connectors. Represented by D. B. Wilson, D. N. Balderston, L. Schofield, H. J. Lamb, H. J. Fuller, C. A. Mudge and E. Heitman.

Elwell-Parker Electric Company, The, Cleveland, Ohio.—Electric storage battery industrial trucks; battery charging apparatus. Represented by Lucian C. Brown, George W. Brown, Fred B. Fink, Capt. Jarvis S. McCrea, Joseph M. Brown, Frank B. Ward, Fred B. Neely and Capt. Frank Kelly.

General Electric Company, Schenectady, N. Y.—Electric welding equipments; motors; industrial control; steam flow meters; turbo headlight sets; miscellaneous electrical equipments for steam roads. Actual demonstration of the electric welding equipment was carried on throughout the convention. Represented by W. J. Clark, Charles Fair, R. E. Woolley, C. A. Raymond, J. J. Liles, C. K. West, G. H. Gilbert, R. G. Standerwick, C. C. Tracy, R. E. Moore, C. H. Williams, H. W. Stewart, P. O. Noble, John Roberts, F. P. Jones, J. F. Myrick, F. S. Hartman, P. A. Dyer, W. L. Merrill, J. A. Seede, J. M. Hollister, J. W. Ham, C. Dorticos, D. B. Rushmore, B. S. Pero, John Eaton, R. S. Bennett, D. K. Frost, C. F. Lawrence and L. W. Shugg.

These two gentlemen are wondering if the Stone-Franklin Equipment could not be applied to the aeroplane they are watching. They are H. D. Rohman and C. E. Walker.

Gold Car Heating & Lighting Company, New York, N. Y.—Vapor, combination pressure and vapor, pressure, hot water and electric car heating systems. Thermostatic control for all types of car heating systems and buildings; ventilators for railway cars; pressure regulators. Represented by Edward E. Gold, E. B. Wilson, A. B. Strange, F. R. Cooper, E. J. Ronan, W. H. Ivers, J. O. Brumbaugh, A. Sheldon.

Gould Coupler Company, New York, N. Y.—Cast steel truck bolsters; malleable iron journal boxes; automatic slack adjusters; cast steel truck side frames; cast steel body bolsters; friction buffers; friction draft gears; cast steel pilot beams; electric car lighting equipment; storage batteries; freight, passenger and engine couplers; turbo-generators for locomotive headlight. Represented by Commodore Charles A. Gould, C. E. Rood, W. F. Richards, G. B. Young, P. H. Simpson, M. R. Shedd, W. H. Sauvage, G. R. Berger, W. F. Bouche, William Garstang and D. C. Davis.

Hauck Manufacturing Company, Brooklyn, N. Y.—Portable heaters; storage battery repair outfits; thawing outfits; pre-heating burners; crude oil furnace burners; kerosene torches; melting furnaces; oil burners; pumping stations; weed burners; tire heaters; rivet forges. Represented by John D. Moore, G. A. Nelson, J. R. Jarvis, G. N. Broadhurst and Arthur E. Hauck.

Heald Machine Company, The, Worcester, Mass.—No. 61, cylinder grinding machine for use on air brake parts and valve motion units or parts which cannot be revolved when grinding; No. 71, internal grinding machine used on bushings, valves and small parts that can be revolved; No. 22, rotary surface grinding machine; magnetic chucks. Represented by Samuel M. Hershey, William Erickson, James H. Cafferty and S. T. Massey.

Hyatt Roller Bearing Company, New York, N. Y.—Hyatt roller bearings as used in railway service cars, freight house trucks, baggage wagons, machine tools, line shafting, counter shafting; a large moving model of a Hyatt roller bearing; small railroad cars equipped with plain bearings and with Hyatt bearings to show comparison, and a lantern slide projectograph machine for illustrating the many uses of Hyatt roller bearings. Represented by D. Gleisen, P. C. Gunion, E. E. Eby, T. P. Cunningham, M. F. Lawrence and H. K. Porter.

Karry-Lode Industrial Truck Co., Inc., Long Island City, N. Y.—One model No. 1 all steel utility electric industrial truck; one model No. 2 all steel low platform warehouse electric industrial truck. Represented by Ernest Tarof, H. A. Spalding, and J. M. Breitenbach.

Kerite Insulated Wire & Cable Company, The, New York, N. Y.—Kerite insulated wires and cables. Represented by P. W. Miller, J. W. Young and J. A. Renton.

Lansing Company, New York, N. Y.—One 3-wheel tractor and 3 trailers. Represented by E. L. Card, M. F. Christensen and W. B. Tourtclotte.

Loco Light Company, The, Indianapolis, Ind.—Loco light generator in operation; headlight case. Represented by H. H. Tomlinson, C. C. Vossler and Fleming Brothers.

Mead-Morrison Manufacturing Company, East Boston, Mass.—Mead-Morrison type "U" grab bucket for crane and derrick work; Mead-Morrison electric car puller. Represented by D. W. Coe, C. D. Bray, F. O. Clukies and R. C. Smith.

Page Steel and Wire Company, New York, N. Y.—Armco iron electric welding wire; Armco iron oxy-

acetylene welding wire and "Copperweld" copper clad steel wire. Represented by W. T. Kyle, C. A. McCune, G. A. Paff and E. C. Sattley.

Pyle-National Company, The, Chicago, Ill.—One type "K-2" 500-watt maximum capacity turbo-generator; one type "E-2" 500-watt normal capacity turbo-generator; one type "E" 1,500 watt turbo-generator; one type "T" 2½ K. W. turbo-generator; one type "M" 3½ to 7 K. W. turbo-generator; one special 18-in. incandescent case and reflector fitted with No. 1450 lamp stand; one standard 18-in. incandescent case and reflector fitted with No. 1450 lamp stand; one model

Representatives of the Gould Coupler Co. wearing the smile that won't come off. From left to right: P. H. Simpson, W. F. Bouche, M. R. Shedd and G. R. Berger.

of the Young valve gear. Represented by R. C. Vilas, J. Will Johnson, Wm. Miller, R. C. Shaal, J. E. Kilker, O. W. Young, C. P. McGinnis, R. L. McIntosh, R. L. Kilker, Geo. E. Haas, J. L. Reese, A. R. Allen, E. M. Thomas, C. T. Tewkesbury and C. F. Owens.

Railway Storage Battery Car Company, New York, N. Y.—Operating exh. on tracks of Atlantic City and Shore Railroad of 50-ft. steel combination passenger and baggage Edison Battery car, in service between Atlantic City and Ocean City. Represented by L. Klopman, F. N. Koziell and C. A. Wipf.

Reliance Electric & Engineering Company, Cleveland, Ohio.—Reliance direct and alternating current motors; Bardons & Oliver cutting off machine. Represented by C. L. Collens, H. M. Hitchcock, A. M. MacCutcheon, A. W. Ray, H. J. Fisher, S. G. Boyd and R. Timmerman.

Safety Car Heating & Lighting Company, The, New York, N. Y.—Pintsch mantle light; car lighting electric generators; car lighting fixtures; Oxy-Pintsch metal cutting equipment; electric fans. Represented by W. L. Conwell, J. A. Dixon, A. C. Moore, W. L. Garland, George E. Hulse, L. Schepmoes, H. K. Williams, R. H. Harvey, J. H. Rodger, H. D. Donnell, V. S. Henry and J. S. Henry.

Schroeder Headlight & Generator Company, Evansville, Ind.—Turbo-generator for electric headlights; electric headlights; oil headlights; electric headlight accessories. Represented by W. A. Carson, F. W. Edmunds, J. Henry Schroeder, L. B. Jones, W. T. Manogue and A. J. Leonard.

Shepard Electric Crane & Hoist Company, Montour Falls, N. Y.—Two electric hoists, one electric winch, and accessories. Represented by A. J. Barnes, R. H. McGredy, H. W. Gledhill and W. C. Briggs, District Manager of New York Territory.

Standard Asphalt and Refining Company, Chicago, Ill.—Sarco mineral rubber floor, refrigerator compound, fabric and No. 6 waterproofing; Sarco battery sealing compound; Sarco pipe coating. Represented by R. F. Trumbull.

Stone Franklin Company, New York, N. Y.—Stone-Franklin single battery coach equipment operating with 23 cells Edison A-4H. Represented by Ralph G. Coburn, Charles E. Walker and Harry D. Rohman.

U. S. Light & Heat Corporation, Niagara Falls, N. Y.—Complete carlighting; axle equipments; direct current arc welder converter; alternating current arc welding motor generator. Represented by W. L. Bliss, H. A. Matthews, R. H. Van Nest, R. Bauer and W. B. Turbayne.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.—Arc welding motor-generator; small turbine generator unit; motor driven grinder; small portable drills; electric fans. Represented by J. C. McQuiston, J. C. Bair, J. Andrews, J. A. Albercht, W. P. Cochan, C. M. Harris, F. O. Kirkpatrick, H.

Two members of the Transportation Engineering Corporation discussing an important (?) matter. H. G. Thompson on the left and F. V. McGinness on the right.

C. Mode, R. F. Moon, W. H. Patterson, Charles Rabbons, R. J. Ross, H. Stinemetz and E. W. Wise.

Wilson Welder & Metals Company, Inc., New York, N. Y.—Wilson plastic-arc welder. Represented by J. O. Smith, R. S. Drummond and Claude Hartford.

Yale & Towne Manufacturing Company, New York, N. Y.—Chain blocks; electric hoists; trolleys (I-beam) winches; portable floor cranes; locks and hardware. Represented by C. W. Beaver, A. L. Connor, J. F. Stoldt, H. R. Butler and W. C. Bigelow.

Trials and Troubles of a Car Lighting Man

Hinkey Dee Hands Out Some Wonderful Advice and Jimmy Goat Accidentally Becomes a Great Hero

"HELLO, Hinkey Dee! How are you today?" said Jimmy Goat as I reached the battery house. I replied, "Fine, Jimmy, I never felt better in me life. How are you today, Jimmy?" Jimmy said, "Oh, I'm all right, but the boss just give me one of them emergency jobs. He said a car was reported with lights in trouble on a special train that would stop at the station for five minutes and that I was to do me best to get lights on the car in trouble." I felt kind of sorry for Jimmy when he told me this, because I knowed he wasn't as good as me on car lightin' and naturally a little rush job like that would make him all nervous and upset. So I says, "Well, Jimmy, if you'll wait a second I'll be right back and will go over to meet the train with you and maybe I can give you a little advice." Jimmy said, "Will you, Hinkey? All right, I'm much obliged and I'll wait right here for you."

When I got back to Jimmy he and Eddie Ram were arguin' and talkin' as loud as anything. Eddie Ram said, "Look-a here, Hinkey Dee, and settle this argument, will you?" I said, "Why, sure; what's up." Then Eddie said, "Now, Hinkey Dee, what's the lights on these cars that has only a set of batteries and lamps; isn't that two-phase current? Jimmy Goat says its three-phase and I says it's two-phase."

I had a good laugh to meself and said, "Well, your both wrong, because it ain't three-phase or it ain't two-phase; no, its four-phase. I'll tell you how you can tell. When you go in a car walk right up to the place where you turn on the lights and count the number of plug fuses and snap switches, and either divide the number of plug fuses by two or multiply the number of snap switches by one, and the result will be the phase of the current. For example, you say you had a car with four snap switches and eight plug fuses. Just take the number of plug fuses, which is eight in this case, and divide it by two, which will give you the result of four, which means it's four-phase. Or, on the other hand, take the number of snap switches, which is four in this case, multiplyin' by one you will have 4 x 1 or 4, which means four-phase." Eddie said, "I'm sure glad to know how to figure that out; thanks, Hinkey Dee." Jimmy Goat said, "Well, sir, I never thought it worked out that way, but by golly I'll not forget that and I'll bet you a dollar I'll know how to figure it out the next time."

I said, "Well, I don't mind a tellin' you fellers anythin' you want a know about car lightin', if you'll only ask me. Now, Jimmy, we had better get a wiggle on or we'll miss that train at the statin."

Well, when Jimmy and me arrived at the statin the statinmaster said, "Are you fellers electricians?" I said "You bet your life, if we ain't no one is." "Well, boys," he said, "I want you to do your best and get lightin' on this car when it arrives." I told him to just leave it to us. Jimmy said, "If we are boys, I wonder where that guy gets the men from." I told Jimmy that he was only sayin' that to be sociable. We waited a few minutes and I heard a whistle. Jimmy said, "Here she comes, Hinkey," and in rolled the train. The conductor told us it was the car next to the engine that had dim lights. The train was crowded with passengers and the conductor told us he wouldn't mind so much about the lights only the train wouldn't reach the end of the run before midnight and that they would be up against it if the lights weren't fixed up.

I read on the switchboard "60-volt equipment." Jimmy said, "Gee, Hinkey, these lights are dim, the battery is down and out, only tests 31 volts." "Good, Jimmy," I said, "I have an idea. Lets take the 60-volt lamps out of the car and apply 30-volt lamps; then they'll have bright lights even if the battery is all in." Jimmy said, "Hinkey Dee, your great, why your a wonder! How in the world do you imagine these things so quickly." I said, "Jimmy, I always had a good level brain but hurry let's get those here lamps in quickly." We took all the

The old handle broke away from the crate and me and Eddie flew across the tracks as if we had been shot out of a gun

60-volt lamps out and put in 30-volt lamps and the train left without a minute's detention. I told Jimmy he had better go along with the car to be on the safe side but that I didn't think it was necessary for both of us to go.

When I got back to the battery house I didn't tell the boss about it because I thought I'd let Jimmy get all the credit for it and anyway it was Jimmy's job. You see I not only have a good brain, but I have a good principle

also. You know a feller to be good on car lightin' like me and to have a bunch of friends on the railroad you have to treat fellers right. Thats me every day in the week.

The boss came over to me and said "Hinkey Dee I sent Eddie Ram over to look at a crate on Car No. 23 on No. 40 track and he tells me that the crate is stuck in the battery box and he can't pull it out." I said, "Well, why don't he use a bar and loosen it, that what bars are made for." The boss said, "You go over and show him

The passengers started to jump out of the car windows and I got blinded, fell off the ladder and as I fell, me arm got tangled in the emergency cord and the emergency brakes went on.

how." Mind, you, show him how! That's what makes me feel good when the boss tells me to show somebody how to do somethin', that shows me how good I am. I walked over to the car and there was Eddie pullin' and pullin'. I said, "What are you tryin' to do, Eddie?" He said, "Now no foolish questions Hinkey Dee, I'm tryin' to get the crate out, what did you think I was tryin' to do, fly a kite?" I said, "Well, you poor boob, you'll never know nothin', go get a bar and I'll show you how to get it out easy." Eddie was back with the bar in short order and I tried to raise the crate with the bar, but the gosh darn thing wouldn't raise. It was stuck as tight as could be. I said, "Get hold of the handles Eddie and let's pull." Gosh, but we did pull, we pulled, and pulled, and pulled, and pulled, and the gosh darn thing wouldn't pull. I started to sweat and so did Eddie. Finally I said, "Rest a minute, Eddie, and then we'll give her a good pull." We rested for a while then I said, "Now Eddie, one—two—three—pull!" Crack—biff—bing—bang! The old handle broke away from the crate and me and Eddie flew across the tracks as if we had been shot out of a gun. Sam, the cop, was passin' at the time and I dived head first right into Sam, landin' him right below the chest. Eddie tried to stop by grabbin' poor Sam by the legs, just like a football player makin' a flyin' tackle. Gosh, we twisted poor old Sam all out of shape. He was goin' to lock us up at first but when we explained how it all happened he let us go. I told the boss all about it and he said he knew darn well we'd bust something before we were through.

That evening on the way home from work I heard the newsboys yellin' "Extra, extra, All about the railroad accident!" "Gosh," I says to meself, "wonder where the wreck was," so I walked up to a newsboy and bought a paper. By Jimminey Christmas, did my eyes deceive me or was I dreamin'! There on the front page was a picture of Jimmy Goat the Hero! By Golly I could hardly realize it but honest injins it was Jimmy himself sure enough. I was so surprised I could hardly read it but I finally succeeded in readin' all about Jimmy bein' a hero.

The paper stated that somethin' happened to the lights, lightning struck the line or something like that, in one of the cars and the passengers were jumping out of the windows when Jimmy Goat cool as a cucumber pulled the emergency cord stoppin' the train instantly, but flattening the wheels of all the cars on the train and ripped up the rails. "Gosh," I says to meself, "Jimmy made a good job of that and has made a name for himself. Mind you, lightnin' hittin' that car. By Golly that must have been some experience."

I was so anxious to see Jimmy that I could hardly sleep that night thinkin' about him. So the next mornin' I was up bright and early and off to work. I got to work before the boss and pretty soon in walked Jimmy. I grabbed Jimmy by the hand and said, "Hello, Jimmy, I'm glad to see you. Gee, your a lucky guy. Tell us all about it." "Well," says Jimmy, "I had the experience of me life. We got goin' at a good clip and I had took a ladder and was fixin' one of the lights when all of a sudden the lamps started to bust. Great Heavens, Hinkey Dee, but they did shoot when they busted; the passengers all got scared and started jumpin' out of the windows. I got blinded and fell off the ladder and as I did my arm got tangle in the emergency cord and the emergency brakes went on and talk about pilin' up cars and people and chairs, why Hinkey Dee it was just like a cyclone." I said, "Well, Jimmy, what caused it?" He said, "Oh, I guess it must have been lightnin'—but it all happened so quickly I don't remember much about it, Hinkey."

Just then the boss arrived, so I stuck around to hear what the boss was goin' to say. I knowed he be proud of Jimmy. "Well, Jimmy," the boss said, "according to the newspapers you did some great work." Jimmy said, "Yes, boss, I did the best I could." "Now, Jimmy," the boss said, "I want you to tell me all about it, step by step, from the time you left here to meet the train." "Well, sir," says Jimmy, "I started for the train and I met Hinkey Dee, he went with me to meet the train and when it arrived he told me of a scheme that he had worked out and boss it was a good one." Gosh, when Jimmy said that I felt good, I shoved me chest way out. "Go on," said the boss. "Well, sir," says Jimmy, "the lights were dim, the battery tested only 31 volts. It was

a 60-volt car and Hinkey Dee said to put 30-volt lamps in the car and the lights would be bright; so we did and boss the lights were fine until we got goin' fast. Then something happened like lightin' hittin' the line and all the lights blew out. The passengers started to jump out of the car windows and I got blinded, fell off a ladder and as I fell, me arm got tangled in the emergency cord and the emergency brakes went on. And say, boss, maybe things didn't stop in a hurry. Yes we stopped so quickly that all the passengers that didn't try to jump out of the windows stood up and bowed." Then the boss said, "What's the number of that car, Jimmy?" Jimmy said, "Number 41076." "Why," said the boss, "isn't that car equipped with an axle generator?" "I don't know," said Jimmy. The boss pulled a list out of his pocket and said in a sharp tone, "Why of course it is an axle generator car. Why, Jimmy Goat, don't you know better than to do a stunt like that. The idea of puttin' 30-volt lamps in a car equipped with a 60-volt generator. Common sense should tell you that when the generator picked up it would burn out all the lamps."

Jimmy said, "Oh, I guess that was what the brakeman was tellin' me about when he said he had put a new generator fuse in somethin' but that they hadn't gone fast enough to make any electricity since he put it in. But, boss, I wouldn't have put 30-volt lamps in the car if Hinkey Dee hadn't told me to. It's his fault." There's where I got mad. I said, "No, I didn't tell him either boss, I just helped him, it was his job."

"By golly," said the boss, "I don't know which one of you fellers is the dummest, you are sure a couple of wise guys." I was sore at first but when the boss said that why I felt better because I wouldn't stand for him sayin' anythin' about me, Hinkey Dee, the car lightin' expert.

TWO ELECTRICAL INSTALLATIONS ON THE GRAND TRUNK PACIFIC

By A. C. Turtle

Fully 40 per cent of the locomotive repairs on the Grand Trunk Pacific railway for the past four years have been done at Edmonton, and recently the work has been considerably increased at this point. The roundhouse at Edmonton has a capacity of 22 stalls, 8 of which are used for both light and heavy repairs. Considerable difficulty has been experienced in arranging for the movement in and out of dead engines or engines partly stripped and also in moving them when it is desired to place them over drop pits for the operation of removing the wheels. Any railway man will appreciate these difficulties when the fact is considered that there is no track running through the roundhouse and that all such movements must take place over the turntable. In order to make these movements it has been necessary either to pole or chain engines in from the table to certain pits. In doing this work trouble was experienced by the snapping of poles, also by track movement, and in order to avoid these difficulties an electric driven tractor was applied to the side of the turntable as shown in the illustration.

The worm gear of this outfit was a 20-h.p. size and was attached to the table by means of an angle iron framework. The drum used was taken off of a small size steam crane and trimmed down to suit the requirements of this apparatus. The clutch was applied so as to have perfect control of the cable drum at all times and so as to leave the motor running and therefore have a maximum force when taking hold of the load. The motor employed was a 15-h.p. 600-volt machine of the three phase, 60-cycle squirrel cage induction type.

To draw an engine from the roundhouse a ¾-in. plough steel cable was wound around the drum. This cable was of sufficient length to reach the snatch block in the roundhouse and was supplied with a hook at one end. Another cable of equal length was fitted with a hook and ring at respective ends so that this link could be attached to the first cable for the purpose of pulling engines off the table into the roundhouse. When not in use this second cable was laid between the tracks outside of the roundhouse. This method of handling the cable is advantageous in that it saves time in running it onto the drum of the tractor.

The above described apparatus was designed to exert a tractive force of 20,000 lb. hauling at the rate of 40 ft. per minute and has been found satisfactory.

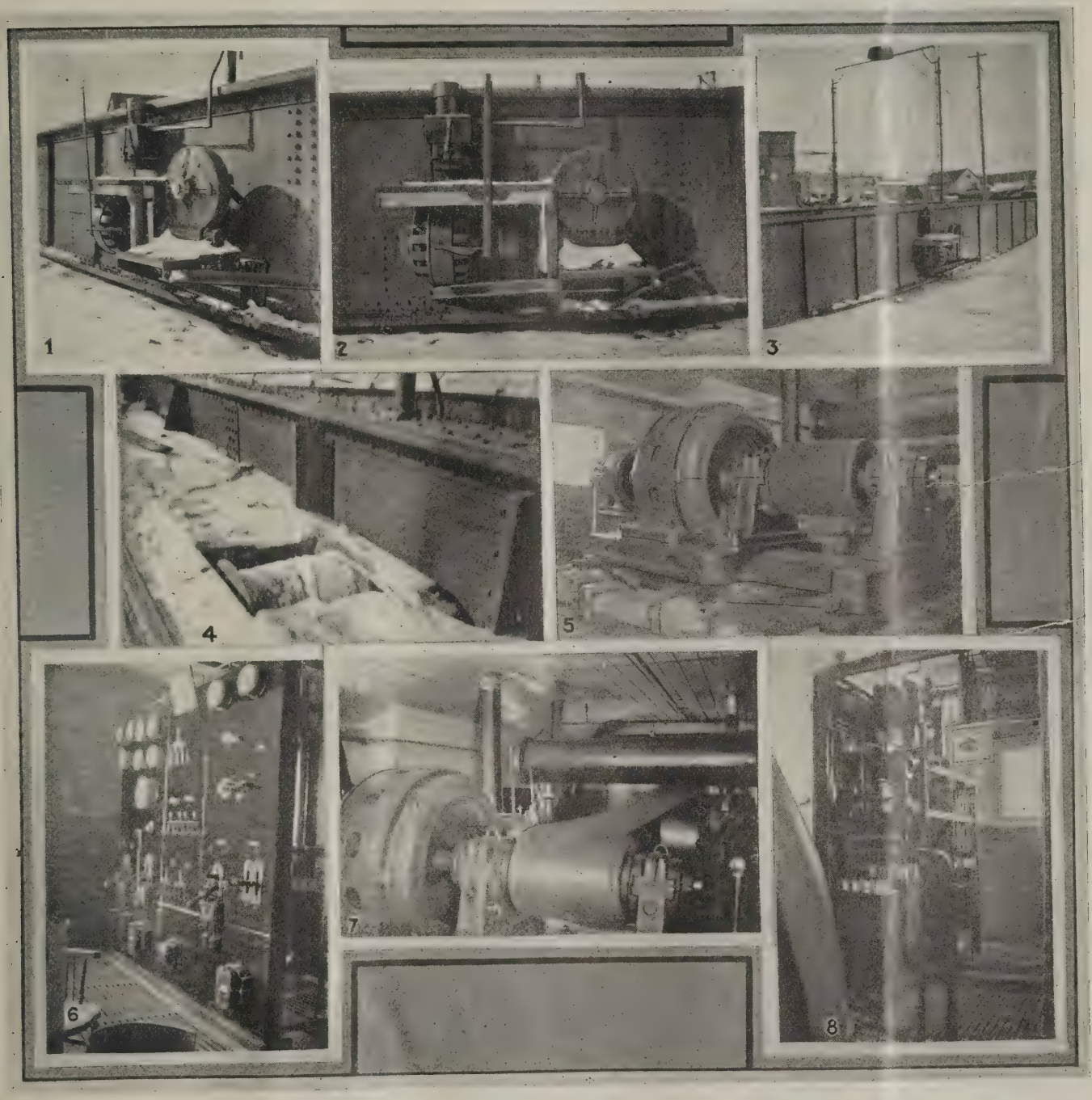
Air Compressor Operated by Synchronous Motor

Owing to increasing work and therefore increasing demand for air and boiler capacity at Edmonton, various plans were made in the fall of 1917 for the attainment of this result with a minimum of outlay. One arrangement consisted of augmenting the capacity by installing two more boilers, but on looking into this it was found that the layout and amount of space available would make a very expensive installation as against a proposal for applying electric drive to the then steam driven air compressors which would cut down the requirements in steam and enable the present boiler plant to meet requirements. At this time there was 250 horsepower in induction motor drive scattered throughout the shops, having a power factor varying between 65 and 70 per cent, while the shop itself was located at the end of a 4½-mile feed line operating at a voltage of 2,200 to 2,300.

A village adjacent to the shops also received energy for light from this line, and therefore was subject to the natural fluctuation in voltage that could not be avoided when starting the motors. While no penalty was in force relative to low power factor in connection with the supply of energy there was a possibility that in the future some such penalty would be enforced because of the fact that the city of Edmonton, which owned the distributing system, is under agreement with the company supplying power to them to keep a power factor of at least 85 per cent to the power-house switchboard. In the interest of good engineering and in consideration of these facts, it was decided to use one large 200-h.p. synchronous motor on the air compressor at this point.

It may be interesting to note the methods used in making the change of the large air compressor. All stuffing boxes were cleaned out and babbitted, and sight feed lubricators attached. The pistons were removed; also the fly wheel, and a cast iron pulley substituted in its place. An automatic unloader was applied at the air intake. The inter-cooler was raised 13 in. and a special spreader casting applied so as to allow proper belt clearance. The total change was made so as to tie up the compressor for a minimum length of time. It was found that when running, the mechanical horsepower actually

required was 160-h.p. pumping air at 105 lb. pressure, 1050 cu. ft. per minute. It was possible to obtain unity power factor and to raise the energy pressure 150 volts on the line by means of exciter adjustments. One 150-h.p. boiler was put out of service and considerable improvement in the air supply was also obtained on account of its not being dependent on the steam pressure of the equipped with watt meter, reactive meter and voltmeter. One 550-volt power panel with similar relays for shop motors, one lighting control panel and one synchronous motor, protective and starting panel with A. C. and D. C. ammeters are included. All transformers for 550-volt service as well as auto-transformers are contained in the fireproof vault in the rear of the switchboard.



1.—Worm Gear, Clutch Motor and Starter. 2.—Side View of Same. 3.—Arrangement of Turntable Contact and General Wiring Scheme. 4.—Cable Drum. 5.—View of Motor, also Showing Air Receiver; Steam Cross Head in Background. 6.—Front of Switchboard. 7.—Motor Installation Complete. 8.—Rear of Switchboard.

roundhouse boilers. The air compressor is of the cross compound steam-driven, two-stage air duplex type. The synchronous motor is of a self-starting, three bearing belted type, taking energy at 2,200 volts, three phase, 60 cycles with a rating of 200 horsepower at 720 r.p.m.

The switchboard apparatus consists of one service control panel with no voltage and overload relay, and is

All of the apparatus, excepting the power panel, were purchased new, for arranging control from the service location to all lighting, welding and power apparatus, therefore, bringing the whole into line with modern practice. The power panel has been in service for two years in another location in the shops, but was eventually made part of the complete switchboard.

Training Operators For Arc Welding*

Guiding an operator's hand

Outlining the Methods Which Have Been Used Successfully in Educating New Men in the Art

By E. Wanamaker and H. R. Pennington

BEFORE electric arc welding of any kind can be done by any one learning to be an operator there are a number of fundamental principles concerning the art which must be learned and also a certain knack of arc manipulation which must be acquired. The fundamental principles can be obtained through study, or from a competent instructor, but the knack of arc manipulation can be acquired only by practice.

Classification of Electric Arc Welding Operators

Electric arc welding has developed many classes of operators and the question has been asked, "Who is a skilled operator?" In our experience we have found that operators are divided into two general classes. These are, universal operators and specialized operators. The first class stands by itself as its name indicates. It is not subdivided as is the case of the second class. Universal operators include those who are able to apply electric arc welding to all classes of work and kinds of materials to which the process is adapted. Their skill has been gained through broad mechanical experience, diligent study of mechanical principles, together with extended study and experience in arc welding. Those men who have become universal operators are indeed high class artisans and will be much in demand no doubt in many industries.

The specialized operators, as mentioned above, are sub-divided into other classes. Some are highly skilled while others do not require as high a degree of workmanship because of the class of work they perform. At the present time, however, specialized operators might be sub-divided into the following classes:

First, pressure vessel welding—(a), high pressure—(b), low pressure; second, machinery welding, much of which is alloy steel requiring some knowledge as to the influence of heat on steel of various compositions; third, structural welding; fourth, repeat operations, which requires the least experience.

From the foregoing it is apparent that the degree of skill required in the different classes, one from the other, varies considerably; for instance, an operator whose training has been limited to repeat operations would not be competent to do pressure vessel welding, which not only requires first class work but also a knowledge of the particular service the vessel is to perform including a knowledge of the effect of expansion and contraction.

The selection of men who are to become electric welding operators, must be given careful consideration. In many cases operators work under foremen who know little or nothing of the art and who are therefore unable to judge whether or not a weld is being performed in the proper manner. In fact, it is impossible for any one to judge the quality of a weld by the appearance of the completed job. The quality of a weld can be predicted only through observation by one who is familiar with the process, as the weld progresses. In view of this fact it is obvious that unless the operator is of the particular conscientious type and a firm believer in quality work, the degree of success will be very uncertain. The material upon which an operator is working is always in plain view. If his training has been ample (as it should be before he undertakes to make important welds) and if ordinary judgment is exercised, there should be little excuse for the failure of the weld. Conscientiousness on the part of the operator is one of the most important qualifications necessary for successful welding. Next in importance is the mechanical ability of an operator. It has been our experience that men who have had mechanical training, and especially those who are willing to disregard any delusion concerning the process, make the most competent operators.

Starting a Beginner

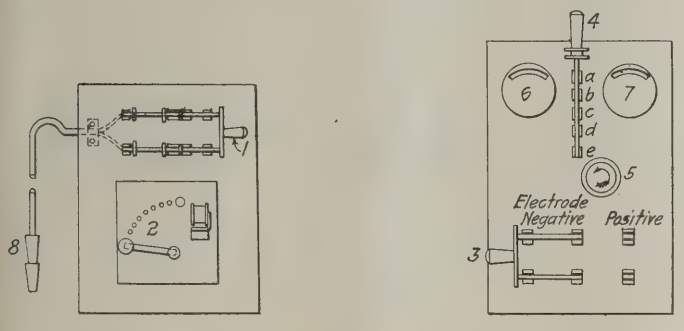
Assuming that the proper equipment, accessories and electrode material have been provided, and that someone has been selected to become an electric welding operator, the first step in the procedure of instructing the beginner will be to teach him to become familiar with the starting of the equipment, and the making of adjustments in order to obtain the proper heat for different sizes and kinds of electrodes for work of various composition and mass. For this purpose brief instructions attached to the control panel of the equipment will serve best, especially when different operators use the same equipment. Instructions of the character mentioned are shown in Fig. 1 for an individual type of equipment.

The next step will be to teach the beginner to make electrical connections from the equipment or panel to the part on which welding is to be done. Assuming that a bare metallic electrode is to be used, and that direct current is provided for welding, the positive lead would be connected to the work and the negative to the electrode holder. This scheme of connections would concentrate the greater portion of the arc's heat on that part, which has the greatest mass and ability to conduct the heat away from the point where the arc is established. To furnish protection from the glare of the arc a face shield, fitted with glass of the proper depth of color tint, as pointed out in a previous article, is required. Until

*This is the fifth article on Electric Welding by E. Wanamaker, electrical engineer of the Rock Island Lines, and H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. Copyrighted, 1919, by the *Railway Electrical Engineer*.

an operator has had sufficient experience to choose glasses suited best to his eyes, it is safe to begin with glasses having a depth of color tint such that when the light of the sky is observed through them, two to five seconds will be required for visibility. A rule which must be observed is to always have the face shield in position before the arc is struck, as it requires only a few flashes to produce bad effects on the eyes.

An electrode of a given size should be chosen according to the mass and nature of the work. For practice,



Motor Panel Generator Panel

To Start Motor:—Switch *No. 3* on generator panel must be open. Close switch *No. 1* on motor panel. Advance slowly handle of starting box, *No. 2*, until lever is held in place by automatic release magnet. Motor will start slowly, speeding up as handle is advanced. In case of portable welder, insert power plug *No. 8* having switch *No. 1* open before starting motor.

To Operate Generator:—Close double throw switch *No. 3* on generator panel to negative or positive side depending on character of work. Always use electrode negative except when welding very thin plates.

Heat Adjustment:—For 3/32-in. or smaller electrodes close switch *No. 4* and adjust voltage by rheostat. *No. 5* to obtain proper heat according to the work at hand. For ⅛-in. electrodes open point *a* of switch *No. 4* which will provide the approximate heat for this size of wire. If heat is not correct raise generator voltage to increase heat or lower generator voltage to decrease heat as occasions require. For 5/32-in. electrodes disengage point *b* and for 3/16-in. electrodes disengage point *c*, proceeding for closer heat adjustments as explained above. Switch all the way out provides maximum heat obtainable.

When not welding or making adjustments on panel, open main generator switch, *No. 3*. This will avoid accidental short-circuit.

To Stop Motor:—Open generator switch *No. 3*, open motor switch, *No. 1*, starting lever of box, *No. 2*, releases automatically.

Fig. 1. Instructions for Starting and Stopping Individual Type Equipment

a ⅝ in. plate, approximately 1 ft. square, will be found convenient and a ⅛ in. diameter electrode 14 or 16 in. long will be the most appropriate size to use for work of this dimension. The holder should clamp the electrode midway between the two ends, especially for a new beginner, as the shorter distance from the work to the holder will require less effort to hold a steady arc. With the electrode at approximately right angles to the plate, (since the arc tends to establish itself along a straight line to the work), touch the electrode on the plate with a slightly dragging touch and immediately withdraw it approximately ⅛ in. from the plate. This procedure is shown in Fig. 2. If the electrode is moved at a uniform speed and at the same time fed towards the plate at the same rate of speed that it is consumed or deposited, (maintaining approximately the ⅛ in. space between the electrode and work), the metal should flow uniformly. If the flow of metal is not uniform when the arc length is correct, the trouble, most always, will be due to one of the following causes:

Improper heat; improper polarity; surface of work not clean; or poor electrode material. In most cases the heat value will be found improper. With all other conditions correct, if the heat value is too low, the electrode will melt away slowly and quietly, one large globule after another, which will not unite or commingle properly with the work. If the heat value is too great the electrode will melt rapidly; the arc will bite deep into the work producing a hissing sound and the deposited metal will tend to boil and will have a porous appearance; also the excessive current will cause the electrode to become red hot or hotter at a distance of ½ in. or more from the end, after 4 to 6 in. have been consumed. When the electrode approaches a white heat the metal will no longer deposit. The heat value is correct when the metal flows smoothly, and unites properly with the work without penetrating or biting too deep into it, or overheating the electrode until approximately 12 in. of electrode material has been consumed, when used on work of medium mass. An arc with proper heat for a given sized electrode, selected according to the mass and nature of the work, will produce a mild metallic crackling sound, which is said to be caused by the rapid condensation of the arc vapor, due to the tendency of the work to conduct the heat away from the point where the arc is drawn.

A Test for Polarity

The polarity may be tested by placing a small carbon rod in the holder in place of the metallic electrode and drawing an arc between the carbon and an iron plate. If the arc is difficult to maintain it is generally an indication that the polarity of the work is negative and the carbon positive; consequently the connections are reversed. If the arc is stable the plate is positive; in which case iron vapor forms more readily than carbon vapor, and the connections are properly made. If tests of the

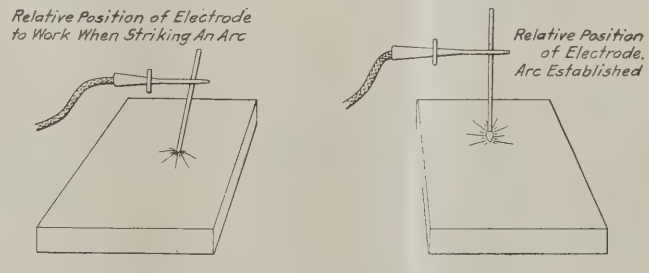


Fig. 2. Methods of Striking an Arc

nature just described are made for the benefit of the beginner, and his attention called to the characteristic features mentioned above, the polarity will soon become apparent to him. Every operator should became familiar with the test. Some operators who have had considerable experience are able to determine the polarity with a metallic electrode instead of a carbon. However, the carbon will serve best for a beginner.

Importance of Clean Work and Proper Arc Length

If the surface of the work is not clean, the arc will play around and the metal will not flow uniformly. The metal of the electrode will unite uniformly on the work only when all dirt, oxide or any foreign substances have

been removed. It is as impossible to have a sound weld where the surface is not clean as it is to heat and unite two pieces of pitch with the surfaces to be united covered with oil. If, however, the oil is removed or floated from between the surfaces to be jointed, a perfect homogenous union will be effected. This fact must not be lost sight of in arc welding if the best results are to be obtained. Poor electrode material is sometimes difficult to detect, as far as the operator is concerned. About the only way he has of determining when the material of the electrode is causing the ununiform flow of metal or an unstable arc, is by knowing that all other conditions are correct.

Again referring to the proper arc length,—while it is judged to be approximately ⅛ in. it is somewhat difficult to determine this, because the shape of the arc tends to obscure the view. In practice if the heat is correct the proper arc length is judged by the sense of hearing more than in any other way. This conclusion is based on experience gained in educating men to become operators. It has always been noted that the guiding of an operator's hand, as shown in the illustration at the beginning of this article, compels him to maintain the proper arc length, thus developing his hearing so that he becomes familiar with the sound of the arc and in a comparatively short time he acquires the ability to hold the correct length. To a certain extend the arc length is determined also by the appearance of the deposited metal, or by the arc potential, which may be measured with a volt meter.

The average arc current and voltage used with bare mild steel electrodes at present indicate the following values:

Size Electrode	Current	Voltage
3/32 in.	60 amps.	14-16
1/8 in.	100 amps.	16-18
5/32 in.	130 amps.	18-20
3/16 in.	170 amps.	20-22

The exact heat value for a bare mild steel electrode of a given size will be determined by the conductivity and composition of the work, which in turn will be indicated by the behavior of the arc, appearance of the metal, etc., as heretofore explained. The sizes of electrodes ordinarily used for various thicknesses of plate are as follows:

Size Electrode	Thickness of Plate
3/32 in.	1/4 in. and under
1/8 in.	3/16 in. and up
5/32 in.	1/4 in. and up
3/16 in.	1/4 in. and up

It is impossible to furnish more definite data as to the relation of the size of electrode to the work, as many factors enter into this determination. For example, a ⅛ in. bare mild steel electrode used on a 3/16 in. plate would require approximately 80 amperes. If, however, the same size electrode was used, for instance, on a locomotive frame, the current which would be required to give proper fusion would approximate 140 amperes, and under ordinary conditions that amount of current would overheat the electrode by the time approximately 8 in. were consumed. The difference in the current demand is due to the difference in the conductivity of the two parts. In the case just mentioned a larger electrode would be more appropriate since it would provide carrying capacity great enough for proper fusion without overheating until the ordinary electrode length had been consumed.

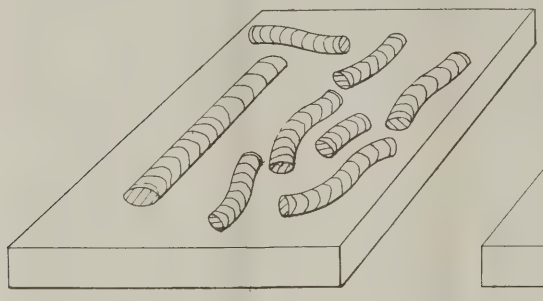


Fig. 3.

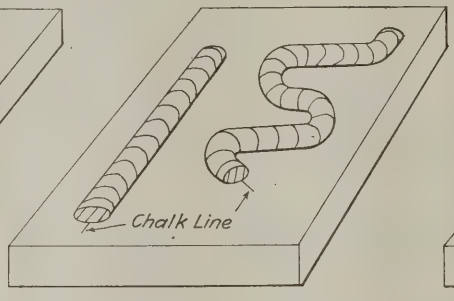


Fig. 4.

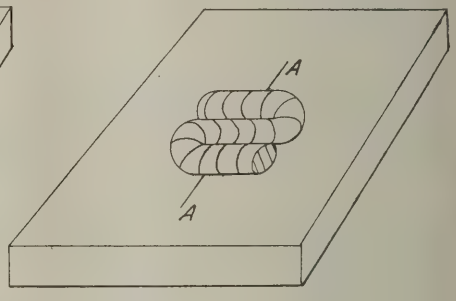


Fig. 5.

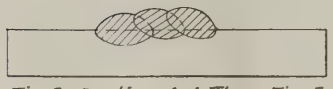


Fig. 6-Section A-A Thru Fig. 5 Showing How One Layer Should Overlap The Other.

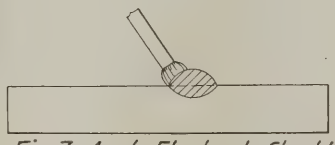


Fig. 7-Angle Electrode Should Be To Give Proper Fusion Between Layers.

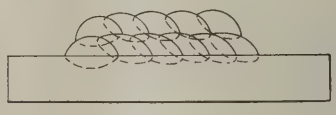


Fig. 8.

Figs. 3 to 8. Practice Exercises for Training Operators to Hold Arc and Follow a Given Course

Practice Exercises

In order for a beginner to become familiar with holding the proper arc, good practice exercises are as follows:

First, with the heat at the proper value, deposit a number of layers on a plate in a horizontal position (Fig. 3) until it is possible to deposit a layer approximately 8 in. long without interruption, which will be smooth and uniform in width and depth. This should be repeated a sufficient number of times to insure it being done at will in order to acquire the ability for maintaining a uniform arc. Second, mark a number of lines on the plate with a piece of chalk, some straight and some crooked, now repeat the first exercise along the chalk marks (Fig. 4). This test will demonstrate one's ability to hold a uniform arc and at the same time follow a certain course. Third, deposit a pad approximately 1 in. wide in the manner shown in Figs. 5 and 6. In starting, instead of the elec-

trode being held at a right angle to the plate as in the above mentioned exercises, it should be inclined slightly before bringing it to a right angle to the surface where the metal is to be deposited, which in this case is not horizontal after the first layer has been deposited. This is shown in Fig. 7. At the end of a bead, or layer, where the arc is broken a bad crater will tend to form, but in order to minimize this condition, when it is desired to break the arc, it is advisable to shorten the length of the arc as much as possible and then break it quickly by pulling the electrode to one side. The exercises above outlined should be practiced not less than two days before work of any kind is undertaken.

Building Up Exercise

There is a vast amount of building up work done by means of the electric arc, using either the carbon or the metallic electrodes. Materials of most every description are reclaimed by this method, and in many cases parts that have been built up must afterwards be machined. When this is necessary the metallic electrode is generally employed, but the carbon electrode may be used, in which case, however, considerably more skill is required to produce a soft weld. The weld must also be sound. It must be free from slag inclusions, air pockets, etc., in order to give a smooth finish. When the metallic electrode is used the weld will be soft, if the proper heat is provided, as outlined above, with a short arc and the work kept clean.

A practice exercise, which will serve to train an operator for this class of work is as follows: Deposit pads of metal such as illustrated in Figs. 3 to 6; these show the course the electrode should follow. Additional layers must overlap the preceding ones, as shown by Fig. 6. When a pad approximately 6 in. long has been deposited, clean the surface perfectly with a chisel or roughing tool to loosen the scale, and a wire brush to remove it, or by the use of a sand blast, then proceed to deposit a second pad, following closely the course of the first. At least three layers should be applied in this manner. The finished weld should then be cut diagonally, and the ends ground and polished. By means of this procedure the soundness or appearance of the added metal may be observed. The necessity of cleanliness will be appreciated by repeating the above exercise without cleaning between layers and careful cleaning as described will readily be apparent when an inspection is made of the weld cut diagonally.

The same exercises as outlined with the work in a horizontal position should now be practiced with the plate in a vertical position until vertical welding is no more difficult for the student than down hand or flat welding. When the practice exercises, as heretofore outlined, have been perfected to a fair degree, the student should be allowed to do unimportant commercial welding for two weeks or more before attempting overhead welding, which is exceedingly difficult at least until the operator has mastered the art of arc manipulation, and is able to judge when the heat value is proper, by the behavior of the arc and the appearance of the metal. These things he can learn only by experience. Practice exercises similar to those outlined for the other positions will suffice for overhead welding.

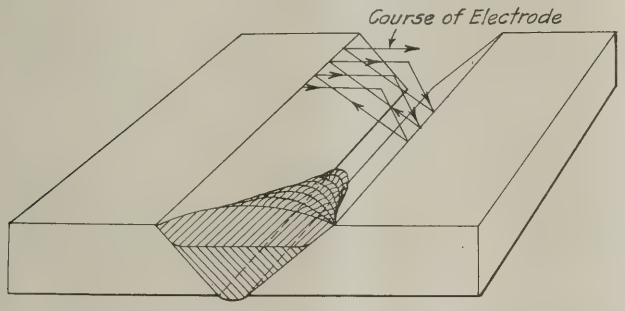


Fig. 9-Showing Method of Applying Metal for Flat Position or Down Hand.

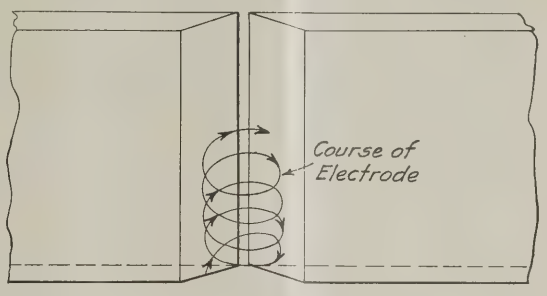


Fig. 10.

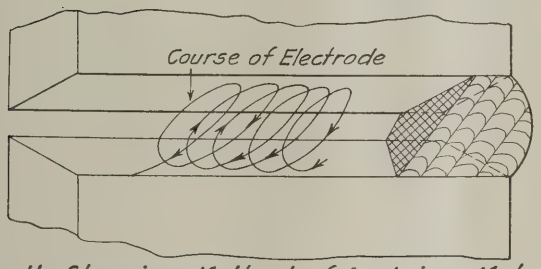
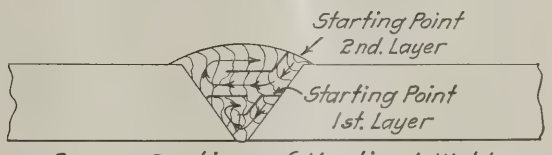


Fig. 11-Showing Method of Applying Metal for Horizontal Position.



Cross Section of Vertical Weld.

Fig. 12-Cross Section Showing Method of Preparing Work for Overhead Weld.

Figs. 9 to 12. Adding Metals to Joints Showing Course of Electrode and Method of Building Up Metal

Method for Adding Metal to Joints

For practice, prepare the plates by beveling the edges to a degree sufficient only to insure access of arc manipulation in order to effect a homogeneous weld throughout. Before starting a weld of this kind the operator should determine a course which the electrode should follow throughout the operation. Methods which have been found satisfactory are shown in Figs. 9 to 12. If the elec-

trode follows the course as indicated by these illustrations, the equivalent of two layers will be made in one run, and the heat will be distributed more uniformly over the beveled edges. This will reduce the tendency of the arc to penetrate through the thin edges, and tend to relieve any bad effects due to rapid cooling.

For overhead welding, use the same electrode course as used for vertical positions. In some cases a strip placed across the gap to serve as a backing for the metal to go against as shown in Fig. 12 will greatly aid in joining the points. The strip can be placed in position from the under side by sticking an electrode to it to serve as a handle.

Methods Used to Resist Expansion Strains

If two pieces of metal are allowed to lie loosely, free to move, they will warp and distort in their relative positions during the process of welding, unless the proper method is used. Yet, if they are clamped rigidly, the stresses which are set up are taken up almost entirely by a slight giving-in of the weld, so that when the parts are released there is no tendency for them to spring out of shape, nor is there any apparent lack of strength which can be regained by supposedly releasing the strains with annealing. This point is reassuring in that it indicates that rigid parts may be safely welded together and no serious stresses left in the weld, provided the welding is done properly.

If welding is started at "A" as shown in Fig. 13, progressing in the direction of "C," over a distance of approximately 3 ft., by the time point "B" is reached, which is half the length of the seam, contraction will have occurred at the point "A," so that as welding is continued from point "B" to "C," the hot expanded metal placed in the V will, in cooling, contract and tend to draw the edges closer together, which cannot be done without placing a strain at the point "A," as indicated by the arrows, thus causing the plates to warp.

A method that has been found to give excellent results

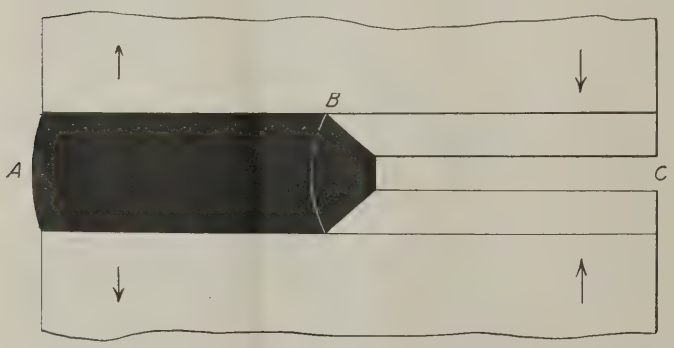


Fig. 13. Arrows Indicate Strains Produced by Cooling of the Metal in the Weld

is called the back-step method (Fig. 14); the object of which is to avoid stresses which are set up by compelling a slight giving of the weld. This method of welding is performed as follows :

The sections from 1 to 7, inclusive, would be welded by starting at "B," section 1, filling in to point "A," returning to point "C," section 2, filling in to point "B," section 1, starting at point "D," filling in to point "C," and so on in this manner until all the sections are completed. Each section should be practically finished before starting the next. The length of each section on any seam should not exceed approximately 10 in. and for short seams should be relatively shorter. The work may be stopped at any time without fear of cracking, provided that the portion of the seam gone over is finished flush.

Manipulation of Carbon Arc Welding

The manipulation of the carbon arc is very similar to that of oxy-acetylene welding. The current required is usually between 300 and 450 amperes at an arc voltage approximately double that of the metallic arc. Fusion is caused by the arc's contact with the work. A filler rod is fed into the arc flame and the molten portion of the

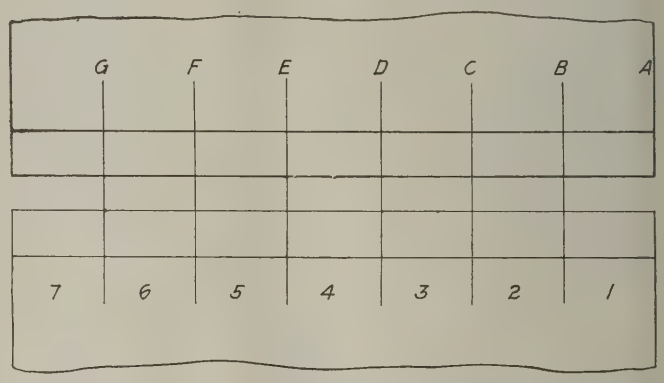


Fig. 14. Work Marked off in Sections Illustrates the Methods of Back Step Welding

work, where the rod is fused also. By manipulation of the arc flame and filler rod, the latter is caused to unite itself with the work and effect a homogeneous union. The character of the work secured by this means depends largely on the operator. A first-class carbon arc operator can produce a very good grade of metal in the weld and one which can be machined without difficulty. One of the principal achievements to acquire in the manipulation of the carbon arc is to compel the arc to be established from the carbon to the desired point on the work.

If the composition of the work is uniform, the arc will form along a line of the least distance between the work and the carbon. However, the fact that more or less impurities are present in the commercial metals, especially castings, this will not always be the case, and the arc will form along a line of the least resistance which may not be the least distance. For example, when a silicon inclusion is encountered, the arc will tend to be diverted around it, and will therefore be unstable. Impurities, which tend to form gas also cause an unstable arc. The carbon arc may be used in many cases for cutting where ragged edges are unimportant; resulting in economy over the oxy-acetylene process.

The time required to train an operator for dependable carbon arc welding will be greater than that required for the metallic arc. In either case much will depend on the individual. Generally speaking, some operators will qualify for repeat operations at the end of 2 or 3 weeks, while others will require more training. For vessel welding, or machinery welding, the best results will not be obtained until the operator has had from 6 to 12 months' experience. Very few operators are qualified for universal welding and those that are have had not less than four years' experience.

Several manufacturers of arc welding equipments main-

tain schools for preliminary training of operators. The courses are good and are of great value to a student. The school is of special value to the small user of arc welding equipments especially when business conditions will not permit securing a competent instructor for training the operator on the job. For large users of arc welding equipments, a welding organization is required. On a number of railroads, a supervisor of welding is employed. He should be a first class operator to begin with and in order to work out satisfactory solutions for the many problems encountered in the various welding operations, a study of mechanical, electrical and metallurgical principles (all of which are involved in the process) should be made. A supervisor for a railroad, for example, should also be familiar with locomotive and car construction in order to apply the process wisely. His duty should be to work out the proper methods for the proper application of the process to the various welding operations. In some cases this will take up his entire time, in which even an instructor to teach the operators, would be required to assist the supervisor.

With an organization of this kind, when a new operator is to be instructed, it has been found good practice to allow the instructor to remain with him for two or three days to give him a start and then leave him on unimportant work for a week or two. Upon the instructor's return, the student usually appreciates the instructions given him, as he will have encountered more or less trouble during the absence of the instructor, also he will grasp the instructions much quicker than he would at the beginning. If the instructions herein outlined are carefully followed, together with the exercise of ordinary judgment, they will greatly assist a new beginner, especially if he is unable to receive personal instructions from a competent operator. The practice employed for various operations will be covered in articles to follow.

AMERICAN ENGINEERING STANDARDS ASSOCIATION

In many lines of engineering much excellent standardization work had been done before the war; the war emphasized its importance and showed most clearly the need of co-operation to prevent the confusion caused by the promulgation of overlapping standards by independent bodies. During the war the government departments coordinated these efforts in certain lines and greatly assisted in unifying them. The American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers and American Society for Testing Materials, recognizing the value of what had been done, invited the government Departments of War, Navy and Commerce to appoint representatives to act with them to continue this work. The body so formed is the American Engineering Standards Committee. It has required considerable time to definitely formulate its objects, and to arrange methods for accomplishing them that would be effective without in any way interfering with the many organizations that have been doing such excellent work in this line.

The American Engineering Standards Committee has just completed and adopted a revision of its constitution which has been sent to the governing boards of all the departments and societies represented on the committee with a request for its ratification.

The new constitution changes the name to American Engineering Standards Association, the change from "Committee" to "Association" more fittingly indicating the wide scope of the interests involved.

The objects of the association are stated as follows:

1. To unify and simplify the methods of arriving at engineering standards, to secure co-operation between various organizations and to prevent duplication of standardization work;
2. To promulgate rules for the development and adoption of standards;
3. To receive and pass upon recommendations for standards submitted as provided in the Rules of Procedure, but not to initiate, define or develop the details of any particular standard;
4. To act as a means of intercommunication between organizations and individuals interested in the problems of standardization;
5. To give an international status to approved American engineering standards;
6. To co-operate with similar organizations in other countries and to promote international standardization.

Means are provided for increasing the number of representatives in the association by invitation or on request. Several important organizations interested in standardization will be invited to appoint representatives as soon as the necessary power is obtained.

The routine work of the association will be conducted by its secretary under the direction of a board of directors. This board will have power to deal with all of the affairs of the association except the final approval of the standards submitted to it.

Any organizations may request the association to approve standards which it has formulated, or to approve committees that it has appointed, and by so doing becomes a sponsor society. Such a request is entirely at the option of the organization that has formulated or expects to formulate the standard. At the request of the sponsor, approval of the standards is given when they are the substantially unanimous conclusions of a committee made up as follows:

(a) Sectional committees dealing with standards of a commercial character (specifications, shop practices, etc.), shall be made up of representatives of producers, consumers and general interests, no one of these interests to form a majority. A producer is a person, or the representative of a firm or corporation, directly concerned in the production of the commodity involved. A consumer is a person, or the representative of a firm or corporation, that uses the commodity involved, but is not directly concerned with its production. General interests include independent engineers, educators, and persons who are neither consumers nor producers, as defined above.

(b) Sectional committees dealing with standards of a scientific or non-commercial character shall consist of persons specially qualified, without regard to their affiliations.

It is anticipated that in nearly all cases the approval of standards and committees by the association will be requested. In case it is considered advisable, the association is authorized to call a meeting of those who would

be interested in the formulation of a new standard or the revision of an old one, to select one or more sponsor societies. The sponsor society or societies will appoint a sectional committee to formulate or revise the standard. This sectional committee will report to the sponsor when its work is completed. The sponsor may then request the association to approve. The association deals only with the sponsor and acts only at its request. Provision is made in all publications that a standard must be referred to as that of the sponsor, using whatever title the sponsor has given it, followed by the statement "approved by the American Engineering Standards Association." The approval may be given in one of three ways as—Recommended Practice, Tentative Standard, or Standard, the expectation being that nothing will be approved as Standard until it has shown that it is generally acceptable.

The association thus acts only to bring together those interested in a common object, and when they have completed their work, will at their request, certify that it has been done in such a manner as to justify its adoption. Nothing revolutionary is proposed, it is merely an extension of present practice. The executive committee of the American Society for Testing Materials now passes on the composition of committees, ascertains that their conclusions are substantially unanimous, and if so, reports them to the society for acceptance or rejection. The association does the same for groups of organizations. Its board of directors performs the same functions as the executive committee of the American Society for Testing Materials, and the association as a whole accepts or rejects. It neither selects sponsors nor sectional committees; it does not consider the subject matter of a standard, nor the procedure under which it is arrived at, except that it requires sufficient information from the sponsor to show that the conclusions are substantially unanimous and that the sectional committee is balanced and representative. It requires that in all publications the sponsor shall be given full credit.

In addition to this work in assisting in the selection of committees and certifying that their work has been done under proper conditions, the association will act as a bureau of information regarding standardization. It will collect information regarding existing standards and as to the bodies that have formulated and adopted them. This will enable it to give promptly necessary information to those who select a committee to formulate a new standard or revise an old one. It will also enable it to furnish information desired by the working committees regarding what has been or is being done on similar or related lines. It will establish relations with similar bodies in other countries and can do much to promote the acceptance of international standards. It is possible to secure international acceptance of American standards more easily through such a body than in any other way.

With these fundamental restrictions of its activities it may be asked whether there is sufficient reason for the existence of the association. This naturally has been carefully considered and it is the unanimous conclusion of the committee and of all of those who have been consulted who have been active in standardization work, that such an organization is urgently needed. In the past there have been many occasions when two or more organizations have formulated standards for substantially the same thing. Often these differences have been very slight, but neither has been quite acceptable to the other party. In the majority of such cases if these organizations had been brought together at the start they could have agreed on a standard that would have been satisfactory to both. The American Engineering Standards Association will furnish a means by which any organization intending to define a standard can readily ascertain what others are interested, and should be consulted in regard to it. At present there is no such means. There is nowhere anything approaching a complete list of the organizations doing standardization work, much less any list of the standards proposed or in preparation. The enormous advantage of having any standard generally accepted, and the much greater probability of accomplishing this if it is prepared under definite conditions that have proved effective in the past, will, it is believed, cause most of the organizations engaged in such work to ask and receive the assistance of the American Engineering Standards Association. It provides definite machinery for securing co-operation and preventing duplication of work. It establishes definite rules securing the absolute autonomy of any group engaged in the development of standards and insures that this group shall receive full credit for its work.

With the assurances of co-operation that the American Engineering Standards Association has already received, we believe that there is no question of the advisability of forming the more broadly representative association. Several organizations have already presented requests for the approval of existing standards, and we are informed that many others only await the notification of the committee that it is fully organized.

It has been impossible to make any public statement of the committee's plans until they had been definitely formulated. This, we feel, has now been accomplished and we can therefore state what it is hoped to accomplish and the methods proposed for the purpose.

ELECTRIC RIVET HEATER

The Berwick electric rivet heater is an inductive type of furnace. It consists of a primary coil to suit characteristics of the alternating current supply and a very heavy secondary coil of only one turn; this secondary is divided at one end into four electrodes.

The electrodes of the heater are opened and closed by foot pedals, and pedal connections are used with compression springs. The primary coil is so constructed that a free air circulation keeps the windings cool.

Rivet heating is done by inserting the cold rivet lengthwise between the electrodes and then closing the line switch, which is very conveniently located at the left side of the heater where the operator has control of the heating at all times, thereby saving unnecessary fuel loss and burned rivets.

This heater is built in four sizes to heat rivets, ¼ in. by 2 in. up to 1⅜ in. by 10 in. It is claimed that the current consumption is 20 kilowatt hours per 100 lb. of rivets.

It embodies the feature of being portable, simple to operate, makes no smoke or fumes, and is economical.

The heater is made by the American Car and Foundry Company.

Report on Train Lighting and Equipment

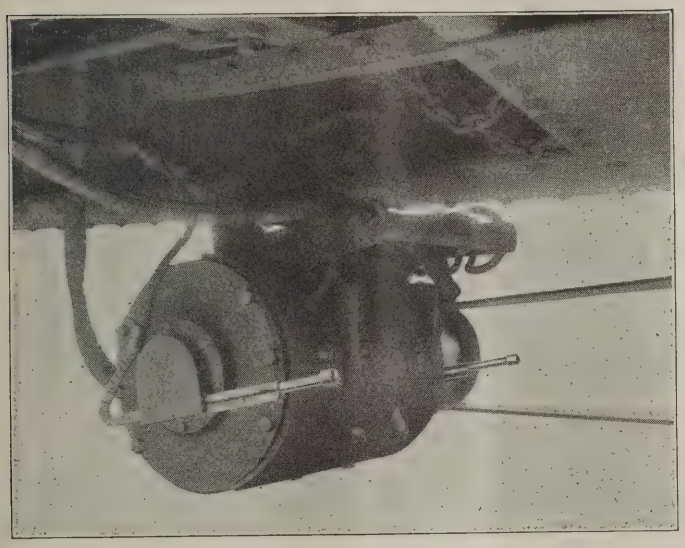
Committee Has Done Much Original Work to Develop Standard Ratings for Axle Generators

THE Report of the Committee on Train Lighting and Equipment which was read on June 21 before Section 3 of the American Railroad Association, at Atlantic City, is of special interest to car lighting engineers. Much pioneer work was done by the committee which is brought out in the following report:

Committee Report

The committee has confined its efforts this year to developing a proposed standard basis for the rating of car lighting axle generators and a method of testing to determine this rating. Some consideration was given to the subject of a proposed general specification for axle generator car lighting equipment, but it was found impracticable to give sufficient study to the subject to submit a report.

There is not, at the present time, any method of rating axle generators, or of testing them to ascertain their rating, that has been accepted by any society or association. The various manufacturers have their own basis of rating and some few of the railroads cover the subject in their specifications, but there is no generally accepted method. In order that when quotations are received from axle generator manufacturers the purchaser may compare them on an equal footing, it appears essential that there be an officially recognized method of rating and of testing to determine the rating.



Generator with Thermometers Applied to Bearings

The current carrying capacity of any electrical apparatus, including axle generators, is dependent upon the ultimate temperature attained by the insulation. The materials used as insulators have been divided by the American Institute of Electrical Engineers into three classes: Class A, Class B and Class C. Class *A* insulation consists of cotton, silk, paper and similar materials, when so treated or impregnated as to increase the thermal limit, or when permanently immersed in oil; also enameled wire. Class *B* insulation consists of mica, asbestos and other materials capable of resisting high temperatures, in which any Class "A" material or binder is used for structural purposes only and may be destroyed without impairing the insulating or mechanical qualities of the insulation. Class *C* insulation consists of fireproof and refractory materials, such as pure mica, porcelain, quartz, etc.

The maximum temperatures to which these various types of insulation may be continuously subjected have been determined by the A. I. E E. to be as follows:

Class of material	Maximum temperature to which the material may be subjected	Maximum temperature rise
*Class A	105 Deg. C.	65 Deg. C.
Class B	125 Deg. C.	85 Deg. C.
Class C	No limits specified.	.....

*For cotton, silk, paper and similar materials, when neither impregnated nor immersed in oil, the highest temperature and temperature rises shall be 10 deg. C. below the limits fixed for Class "A" insulation.

It is further provided that the above temperatures are based on a standard ambient temperature of 40 deg. C., and that when the temperatures are determined by thermometer readings, 15 deg. C. shall be added to the highest temperature observed. This correction shall apply to insulated windings, but no correction is required for commutators, while the correction for bare copper solenoids, etc., is 5 deg. C. Class *A* insulation is now generally used in axle generators, except on commutators where Class *B* is used.

The test to determine the rating will necessarily be made in the shop, where the conditions of operation are quite different from what they will be in service.

With a constant field current, the e. m. f. of any generator is directly proportional (also within limits) to the speed, and with constant speed it is directly proportional (also within limits) to the field current. As satisfactory illumination and lamp life are dependent on an approximately constant voltage, it is obvious that the generator voltage should be maintained between as narrow limits as the range of charging voltage of the battery will permit. Also to maintain the voltage within these limits, it is apparent that the field strength must vary approximately inversely as the train speed, and therefore the maximum field current will be at the minimum train speed.

As the heating of the generator is due principally to the energy dissipated in the fields and armature, the maximum heating must occur at a speed of the armature that will generate sufficient voltage to make the generator carry the current, and as the maximum temperature is limited, the object of a capacity test or heat run is to ascertain the maximum current that can be carried without exceeding this temperature limit, and this heat run must necessarily be made at the minimum r. p. m. that will generate the rated voltage and current.

In service, the following conditions occur, all of

which tend to affect the temperature, as compared with operation on the stand: 1. The commutator's hand-hole covers must be in place, tending to increase the temperature, as the heated air enclosed in the generator cannot escape, while on the stand test they are customarily removed. 2. Due to the movement of the train, the axle generator is subjected to a very effective air wash, tending to decrease the temperature. 3. The intermittent character of the load, due to the train speed falling below the "cutting-in" speed on account of slow-downs and stops will tend to decrease the temperature. 4. The ambient temperature will rarely attain a value of 40 deg. C., and when it does, only for a comparatively short time. 5. The time at which the load on the axle generator is likely to be greatest during the day is the time at which the ambient temperature is likely to be least, and vice versa. What the railroad car lighting engineer desires to know is what the capacity of the axle generator will be in service and not what it may give on a stand test.

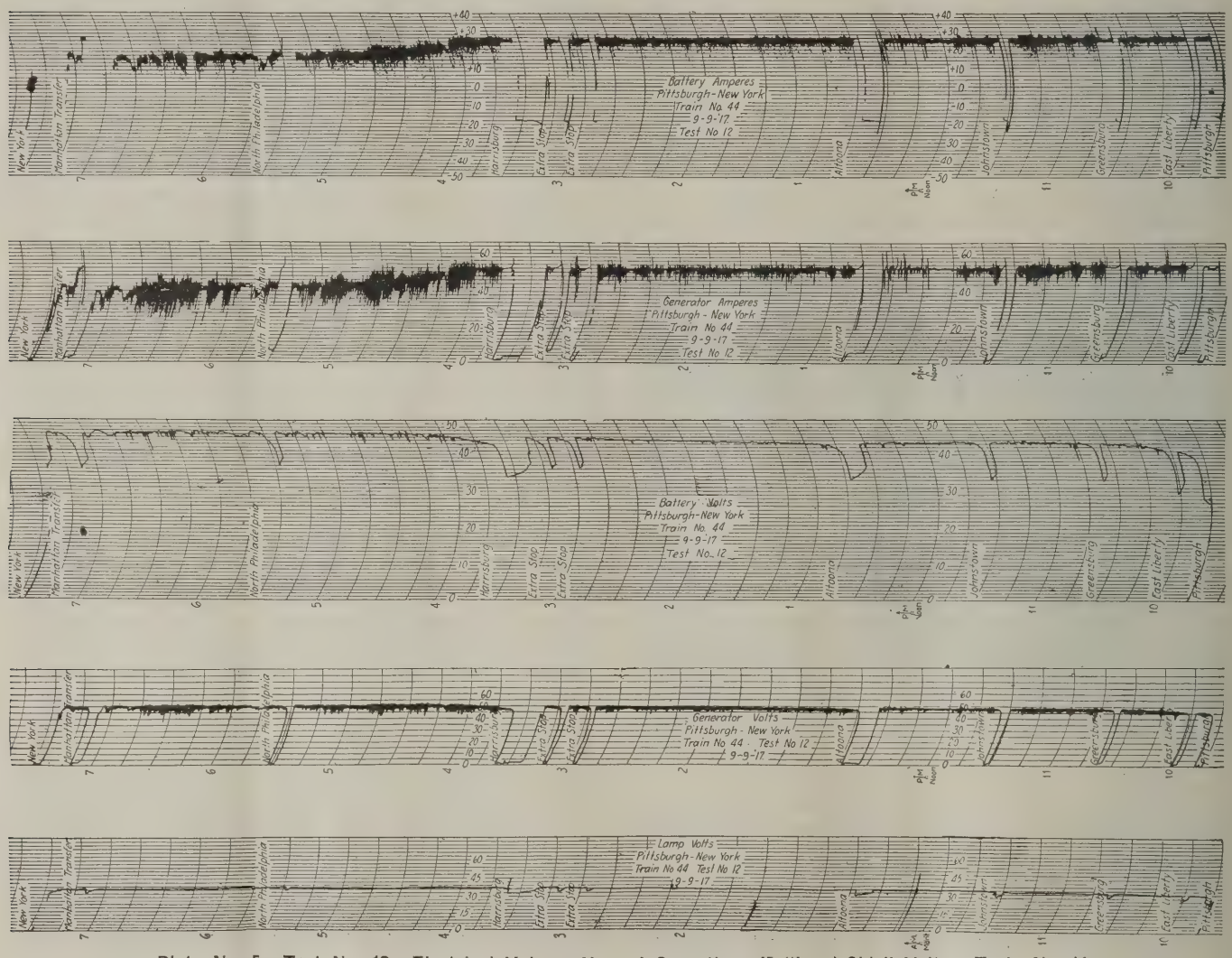


Plate No. 5.—Test No. 12.—Electrical Values—Normal Operation—45 "Load Side" Volts. Train No. 14

A Series of Tests

The committee has, therefore, conducted a series of tests with a view of determining: 1. The rating of an axle generator. 2. A method of testing to determine this rating. 3. If possible, the relation between the capacity as found on the stand test as compared to the capacity in actual service.

These tests are as follows: 1. Stand test for five hours to attain maximum temperature. 2. Stand test for five hours at manufacturer's rated full load. 3. Road test with generators forced to carry manufacturer's rated full load. 4. Road test operating normally. 5. Stand test under same conditions as No. 3. 6. Stand test under same conditions as No. 4.

The apparatus used in making these tests was as follows: A standard make of body-suspended axle generator, rated at 40 volts and 41 amperes net output. A standard make of car lighting battery, rated at 150 ampere hours' capacity, having a normal charging rate of 30 amperes. The number of cells was varied as conditions of load and temperature rendered necessary. Weston portable ammeters and voltmeters. Esterline recording ammeters and voltmeters. Resistance and mercury thermometers. The instruments were calibrated by comparison with laboratory standards and actual readings obtained were corrected accordingly. The axle generator equipment with the thermometers in place is shown in the photograph.

To make the road tests the generators and battery were applied to Pennsylvania steel coach 1893, and the car was placed in service on train No. 12, operated

between Pittsburgh and Philadelphia. The results obtained on this run did not prove satisfactory, on account of the cooling due to the frequent stops of train No. 12 between Pittsburgh and Harrisburg, while between Harrisburg and Philadelphia the run was covered at high speed with few stops, with the result that the temperature of the generator was still rising at the end of the run.

The car was, therefore, transferred to train No. 44,

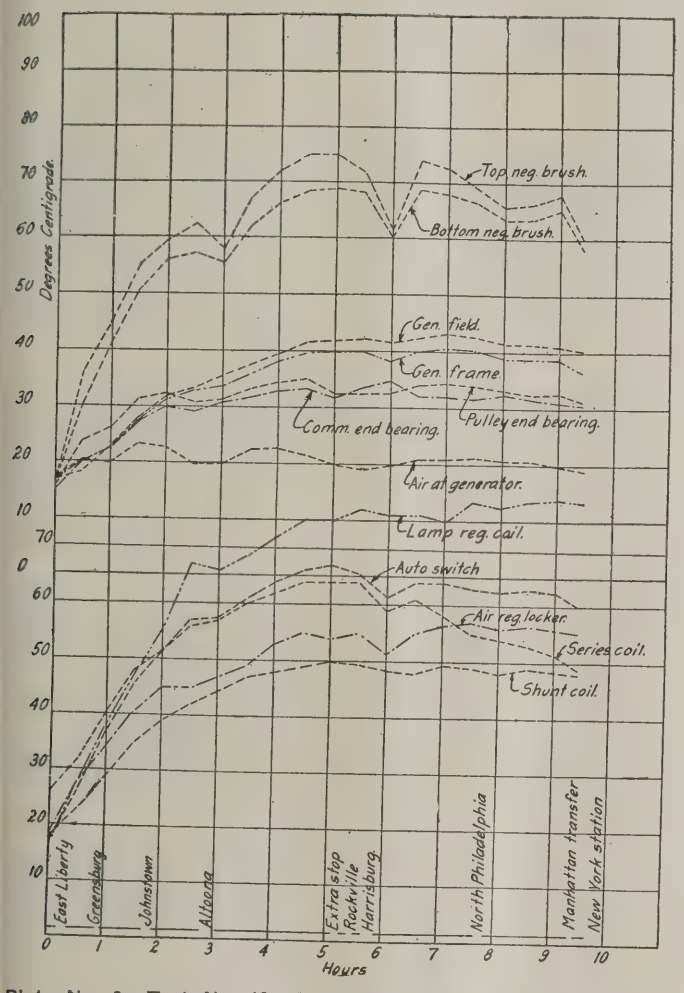


Plate No. 6.—Test No. 12. Temperatures—Normal Operation, 45 "Load Side" Volts. Train No. 44

operating between Pittsburgh and New York, and on this run a number of tests were made. Train No. 44 has a faster schedule and less stops than train No. 12, and it was noted that the temperatures attained on the run made on train No. 44 were higher than the temperatures attained on train No. 12. This indicated that the intermittent load obtained on No. 12, which was occasioned by the frequent stops, considerably more than compensated for the increase in field current at the lower speed.

Considerable difficulty was encountered in obtaining concordant data on these runs, due to the fact that in some of them the control was hand operated and also to other factors over which we had no control. The results obtained from runs Nos. 12, 13, 15 and 16 were selected as being the most representative of the conditions and as conforming most nearly to the normal schedule of the train. On these tests, temperature readings were taken at 30-minute intervals and immediately before and after stops.

Following these road tests, the entire equipment was removed from the car and set up for operation in the shop, where road tests Nos. 12, 13, 15 and 16 were duplicated as closely as possible with regard to load, number and duration of stops and average speed. It should be noted that the speed in the shop tests was not the actual speed as obtained on the road, but the average speed obtained by calculation on the basis of distance and running time between stops.

The data accumulated on these tests are shown on the following plates:

PLATE.	TEST.	DATA.	DESCRIPTION.
1	S-1	Electrical Values....	Run five hours at 43.5 load side volts and constant current value to attain maximum allowable temperature.
2	S-1	Temperatures	
3	SS-1	Electrical Values....	Run five hours at manufacturer's rating 43.5 load side volts, 41 net amperes constant load.
4	SS-1	Temperatures	

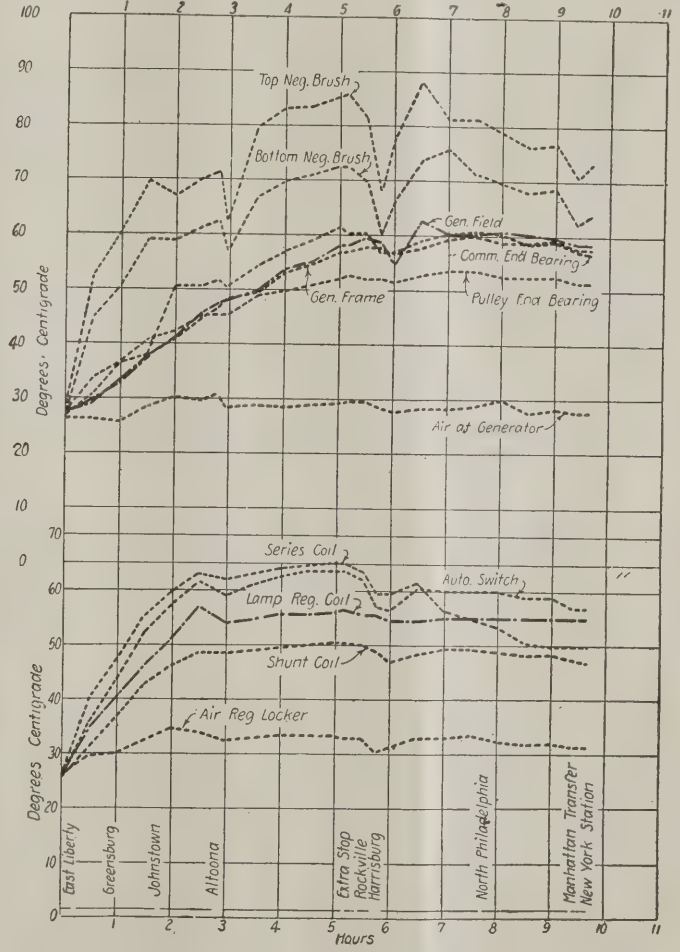


Plate No. 8.—Test No. 12-A. Bench Test Duplicating Test No. 12 on Train No. 44. Temperatures—Normal Operation—45 "Load Side" Volts

5	12	Electrical Values....	Road test, normal operation, 45 load side volts.
6	12	Temperatures	
7	12-A	Electrical Values....	Duplicate of test No. 12 on Stand.
8	12-A	Temperatures	
9	13	Electrical Values....	Road test, constant load 41 amperes net, 45 load side volts.
10	13	Temperatures	
11	13-B	Electrical Values....	Duplicate of test No. 13 on Stand.
12	13-B	Temperatures	
*13	15	Electrical Values....	Road test, constant load 41 amperes net, 43.5 load side volts.
14	15	Temperatures	

*15	15-A	Electrical Values....	Duplicate of test No. 15 on Stand.
16	15-A	Temperatures	
17	16	Electrical Values....	Road test, normal operation 43.5 load side volts.
18	16	Temperatures	
19	16-A	Electrical Values....	Duplicate of No. 16 on Stand.
20	16-A	Temperatures	
21	S-1 SS, 12 12-A, 16 16-A	Temperatures	Comparison.
22	S-1 SS, 13 13-B, 15 15-A	Temperatures	Comparison.

* NOTE.—The electrical data for tests 15 and 15-A were lost and cannot, therefore, be submitted.

[Due to lack of space the charts accompanying the report are not all reproduced.—EDITOR.]

On Plate No. 21, considering the curves for tests 12 and 12-A after the sixth hour, when the temperature of the fields had attained practically constant values, it will be noted that the rise in temperature (generator operating at a forced output of 41 net amperes at 45 load side volts) is 23.6 and 33.2 degrees Centigrade, the difference in rise being 9.8 degrees C. Considering the curves for tests 15 and 15-A, also after the sixth hour, the rise in temperature of the fields (generator operating at a forced output of 41 net amperes at 43.5 load side volts) is 26.1 and 29.9 degrees Centigrade, respectively, the difference in rise being 3.8 degrees.

The difference in rise in the above tests, which, so far as electrical values were concerned, were as near identical as possible, is accounted for by the different

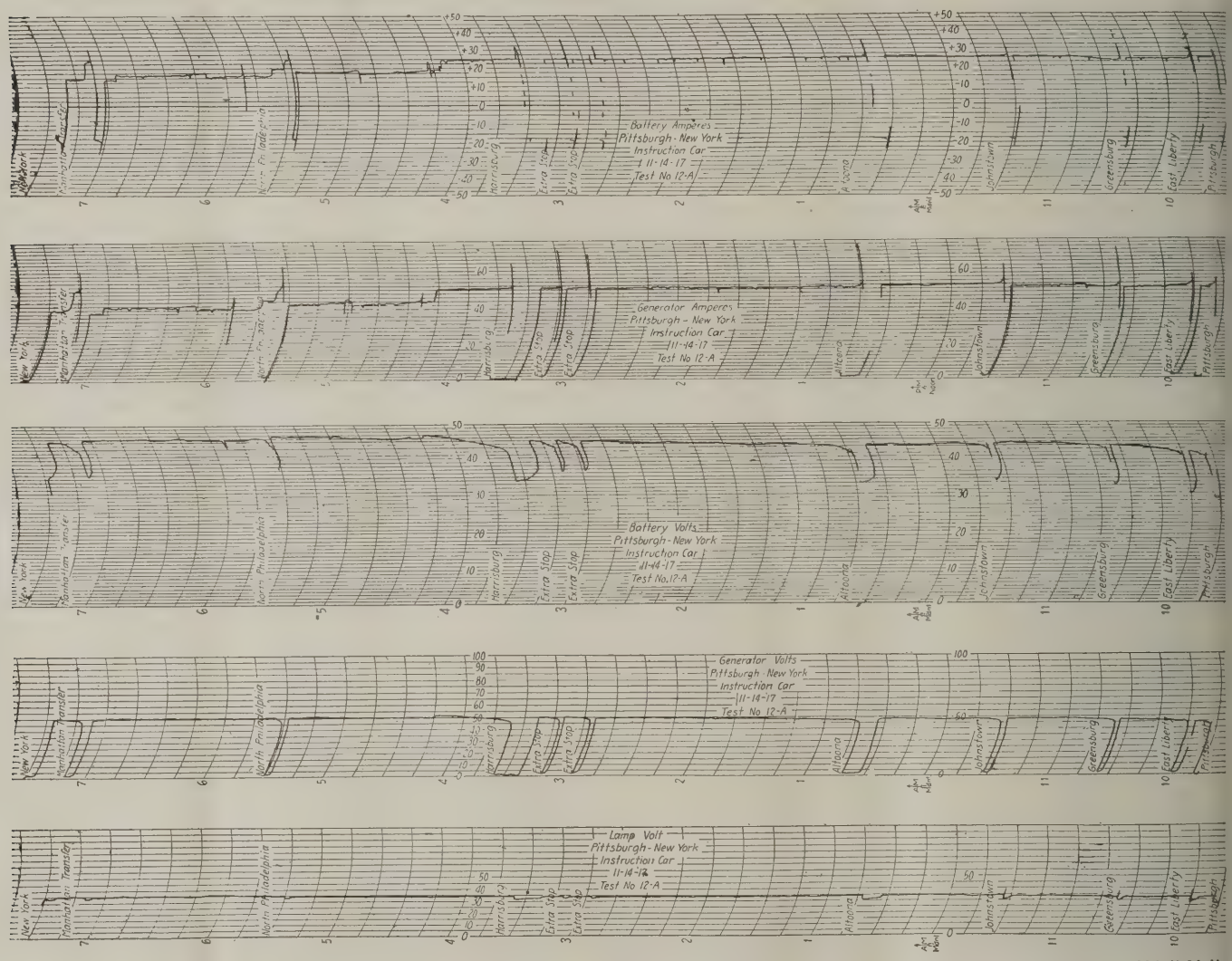


Plate No.7—Test No. 12-A—Bench Test Duplicating Test No. 12 on Train No. 44. Electrical Values—Normal Operation—45 "Load Side" Volts

of the fields had attained practically constant values, it will be noted that the rise in temperature (generator operating in normal manner at 45 load side volts) is 21.3 and 30.7 degrees, respectively, the difference in rise being 9.4 deg. C. Considering the curves for tests 16 and 16-A, also after the sixth hour, the rise in temperature of the fields (generator operating in normal manner at 43.5 load side volts) is 22.85 and 30.46 degrees, respectively, the difference in rise being 7.6 deg. C.

On Plate No. 22, considering the curves for tests 13 and 13-B after the sixth hour, when the temperature conditions of heat radiation on stand and road. The rise in temperature of the field, as shown in curves for stand test SS-1, is 25.5 deg. C. at the end of five hours. This rise is greater than the rise under road conditions as found in tests 12, 16 and 13, and only slightly less than was found in test 15. Also the difference in rise between corresponding stand and road tests is 7.6 deg. for normal operation and 3.8 deg. for forced load operation.

When it is considered that in making what is called the normal operating tests the tests were intentionally started on a battery that was only about one-quarter

charged, and that the output of the generator was, therefore, greater than it usually would be in regular service, and also taking into account that the tests were run in very warm summer weather, it is believed that 5 deg. C. can easily be allowed for the difference in operating conditions on road and stand.

The generator was rated by the manufacturer at 41 amperes net output, so tests were run to determine its actual output. It was inconvenient to obtain the temperature of the field, but it will be noted in the

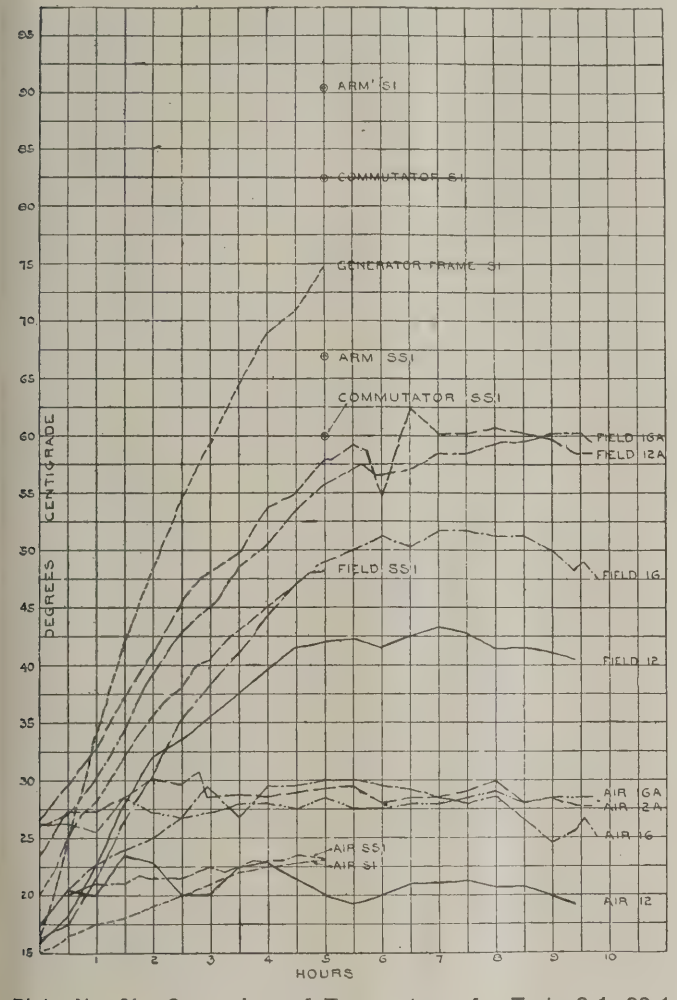


Plate No. 21. Comparison of Temperatures for Tests S-1, SS-1, 12, 12-A, 16 and 16-A

other tests that the field and armature temperatures very closely approximate each other. From these tests, test S-1 was selected as being nearest the condition desired, *i. e.*, a rise of temperature of 65 deg. C. This test was run at 58 net amperes and the actual rise in temperature of the armature, the hottest part of the generator, was 67.5 deg. C.

The ambient temperature of an axle generator in actual service is rarely over 90 deg. F. or 32 deg. C., except in certain limited sections of country where it may attain a temperature of 100 deg. F. or 38 deg. C.

The committee would, therefore, recommend the following:

1. That the method of testing to determine the rating of an axle generator be as follows: (a) That the generator, together with the generator and lamp regulator, if used, shall be connected in a normal manner to dead load resistance in the battery and lamp circuit, and (b) Shall be operated continuously for five hours, with commutator hand-hole covers removed, at the minimum r. p. m. that will generate rated volts at the load side of the generator regulator and carry the current, and that (c) The net current output shall be the armature current less all current consumed in the generator fields, generator regulator, and lamp regulator, if used.

2. That the rating of an axle generator be based upon the following: (a) The rating of an axle generator, when connected and operated as above, shall be the maximum net current that the generator will carry without exceeding the following values:

	Maximum Observable Temperature.	Maximum Observable Rise in Temperature.
Any part of generator or regulators, except commutator, brushes, brush rigging and bare copper solenoids	110 Deg. C.	70 Deg. C.
Commutator, brushes, brush rigging and bare copper solenoids	130 Deg. C.	90 Deg. C.

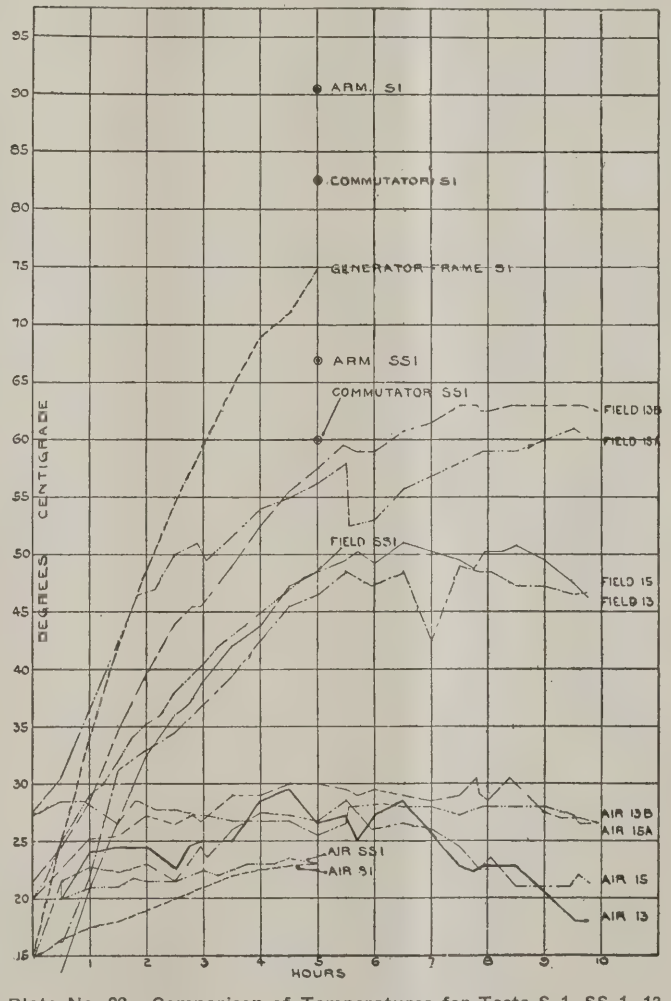


Plate No. 22.—Comparison of Temperatures for Tests S-1, SS-1, 13, 13-B, 15 and 15-A

3. That the rating test shall be made at or above 15 deg. C. ambient temperature.

4. That a badge plate be securely attached to each axle generator which shall show the following: (a) Manufacturer's name. (b) Type number. (c) Nominal voltage of generator (40 volts for 30-volt system and 80 volts for a 60-volt system). (d) Rating in amperes as above determined. (e) Minimum speed in r. p. m.

at which generator will deliver rated volts and amperes.

5. That the above recommendation be submitted to letter ballot as Recommended Practice.

The final meeting of the committee was attended by representatives of all the axle generator manufacturers in this country but one, and the above recommendations were unanimously approved by the representatives attending.

A method of rating axle generators is one of the essential portions of an axle generator specification. The committee, while it realizes that it is impossible to draw a complete detailed specification that would be applicable to all types of axle generator equipment as now commercially manufactured, nevertheless believes that there are a number of essential characteristics that are common to all types of axle generators

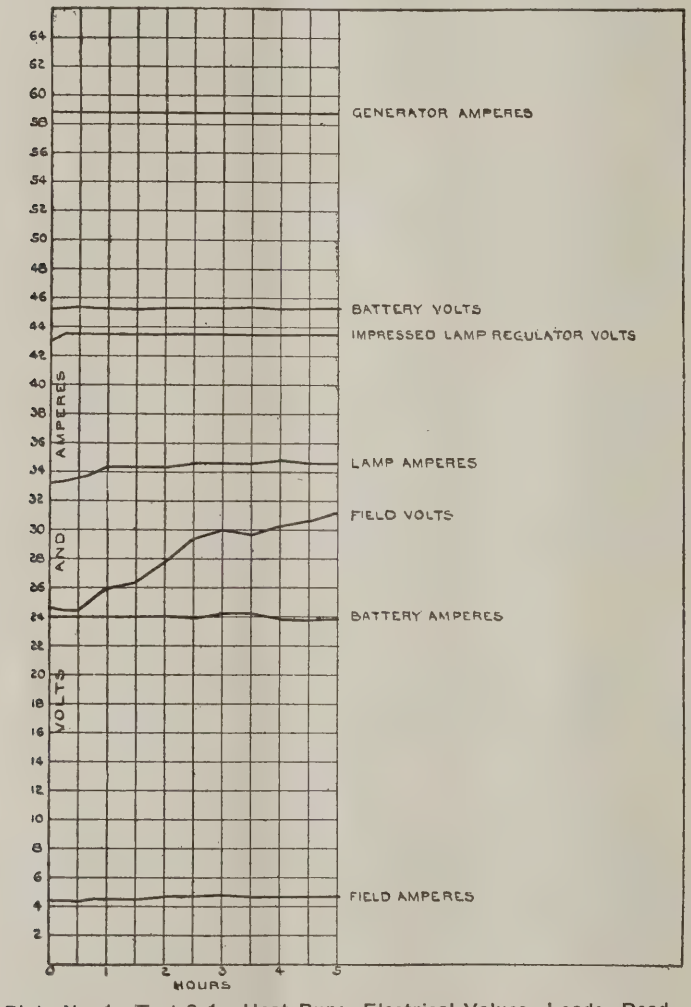


Plate No. 1. Test S-1.—Heat Run: Electrical Values—Load: Dead Resistance, 43.5 "Load Side" Volts, 58 Net Amperes; Speed 16 M. P. H., 333 R. P. M. of Armature

and which would be included in complete specifications. The committee, therefore, recommends that it be instructed to investigate this matter with a view to drawing up a partial specification which will include the features common to all axle generator equipment.

The report is signed by J. R. Sloan (Chairman), Pennsylvania; C. H. Quinn, Norfolk & Western; D. J. Cartwright, Lehigh Valley; E. W. Jansen, Illinois Central; E. Wanamaker, Chicago, Rock Island & Pacific; A. McGary, New York Central, and L. S. Billau, Baltimore & Ohio.

Discussion

Mr. Sloan: Referring to paragraph three on page five, my attention is called to the fact that for trains using a slipping belt, the field strength does not vary inversely with the train's speed. But if you substitute here the words "armature speed" for the words "train speed" it is practically correct. In the table on page

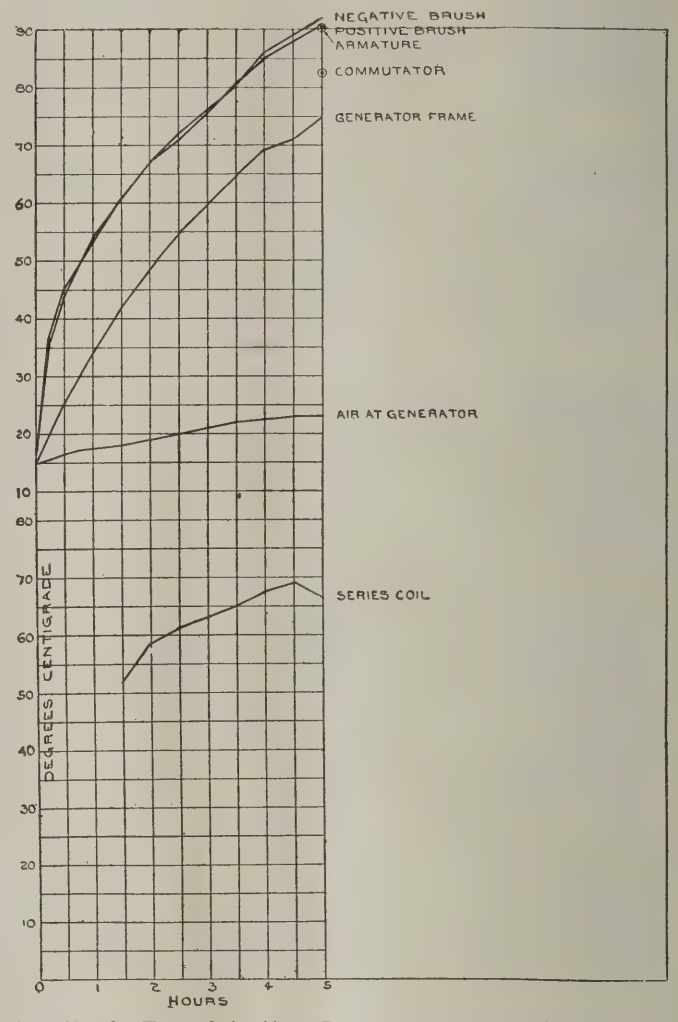


Plate No. 2.—Tests S-1.—Heat Run: Temperatures—Load: Dead Resistance, 43.5 "Load Side" Volts, 58 Net Amperes; Speed 16 M. P. H., 333 R. P. M. of Armature

12, paragraph 2-A, there should be inserted after the words "copper solenoids" the words "resistance units and carbon piles," so it will read "any part of generator or regulator except commutator, brushes, brush rigging, bare copper solenoids, resistance units and carbon piles," shall have a maximum observable temperature, etc."

Mr. Gaines: I move the report be received and the recommendation of the committee be referred to letter ballot, and that the recommendation of the committee relative to further investigation be carried out.

J. H. Davis (B. & O.): The only criticism that I had of the report was in paragraph 3, page 5, to which Mr. Sloane referred in reading the paper.

B. B. Milner (N. Y. C. Line): This report is a very commendable piece of work on the part of the com-

mittee. The method of basing the rating of the generators and the method of testing to determine that rating, as reported by the committee, represents pioneer work. As the committee states in its report, it has never been passed on by any society or association.

The N. Y. C. Lines have in operation some 2,800 axle light equipments which were purchased under, and meet, a specification somewhat more severe than that suggested by the committee in its recommendations on page 12. The temperature rise suggested by the committee as shown on that page is 90 deg. C. As applied to commutators, brushes, brush rigging and bare copper solenoids, the maximum temperature rise prescribed in these specification is 75 deg. C. The maximum allowable increase in bearing temperature is 50 deg. C.

Current output, according to paragraph (c), at the top of page 12, is "the armature current less all current consumed in the generator fields, generator regulator and lamp regulator, if used." The rating of current which the N. Y. C. Lines has been using is the serviceable current, that is the current measured at a point nearest the lamps and the batteries. The paragraph referred to might be made to cover that by including some additional relays or automatic switch solenoids which might be a part of the testing equipment. The service test prescribed is paragraph (b) on this same page is for some five hours under regular conditions of load and speed. Under the specifications referred to the fifth hour of that period of testing is replaced by 15-minute tests with increase in speed and load set up to cover unusual conditions under which the generators may be called to operate.

Mr. Sloan: In regard to Mr. Milner's remarks about 1-C, the net current is specified as the armature current less all current consumed in the generator field, generator regulator, and lamp regulator, if used. That means that what current is put down as net current is what is available for use. We had a fully attended meeting of the committee and representatives of the axle generator companies, and this question of the N. Y. C. specifications was brought up. The committee decided that it could be omitted; that it did not consider that the service which an axle generator underwent was so severe that it had to put an additional test on it. I have received the following communication:

"In the replies from New York Central Lines roads to M. C. B. Circular No. 29, dated January 1, 1919—Circular of Inquiry of the Committee on Standards and Recommended Practice—is included the following from I. S. Downing, G. M. C. B., C. C. C. & St. L., Indianapolis, Ind.:

"There are different ideas and systems of applying generator pulleys to axles of passenger equipment cars. Some roads use special axles for the generator pulley, and it would be our recommendation that such pulleys be designed to conform to standard M. C. B. axles and avoid having special designed axles to accommodate the axle pulley."

(b) "Extract from Minutes of Meeting of the Committee on Standards and Recommended Practice, held in office of the Secretary at Chicago, Tuesday, March 18, 1919.

"It was decided that the subject of generator pulleys for axles of passenger equipment cars, mentioned in letter dated February 13, 1919, from E. Chamberlin, Secretary of Equipment Clearing House, New York City, be referred to the Committee on Train Lighting and Equipment."

I answered that letter to the Secretary of the Committee on Standards. I will quote in part:

"The Committee on Train Lighting and Equipment covered this subject as fully as it could be done, considering conditions as they exist, when they submitted the following recommendations in their report to the 1917 Convention.

"6. Axle Pulleys and Bushing.

"(a) A straight pulley seat shall be provided for the axle pulley.

"(b) If a bushing be used, it shall preferably be secured to the axle independently of the pulley, and shall have an external diameter throughout its length of 7½ in., and be not less than 8½ in. long.

"(c) The hub of the axle pulley shall have a uniform internal diameter of 7½ in., the length of the hub shall be 6½ in.

"(d) The face of the axle pulley shall be not less than 9 in. if flangeless, and not less than 8 in. if flanged.

"(e) The diameter of the axle pulley shall be as large as the construction of the car will permit, preferably 21 in. or 17 in.

"The recommendations were No. 88 in the letter ballot and were adopted, 1817 voting 'yes'; 154 voting 'no' and 'necessary to choice', 1,314.

"These recommendations specify that a 'straight' seat shall be provided for the axle pulley but do not say by what means this end shall be attained. They do intimate that a special bushing is preferred, and this implies that a standard M. C. B. axle is used, as, if a special axle were used, the bushing would be unnecessary. They specify how the pulley bushing will be secured, its essential dimensions and also the essential dimensions of the pulley itself. It did not seem possible to prepare a 'standard' in the shape of a dimensioned drawing.

"If you feel that our committee can go further in the matter, please outline clearly what you would propose."

The stand of the committee is that the action desired has already been taken, and is recommended practice of the Association.

W. E. Dunham, (C. & N. W.): It would have more force with the members of the Association if the opinion of the Committee on Train Lighting was expressed a little more distinctly in recommended practices and standards. An axle shown in the recommended practices has a straight seat, and it is the appearance of that axle in the proceedings which leads a great many to continue to use it. I would like to see the action of the Convention such that the straight sided axle will be eliminated entirely from the records.

Mr. Milner: I support the elimination of the special axle, or what appears to be a special axle, from the records of the Association. The N. Y. C. Lines, are eliminating its use, and using only M. C. B. standard axles to which bushings are applied. If paragraph C, at the top of page 12, were amended in accordance with Mr. Sloan's remarks, it would be entirely clear.

Mr. Gaines: If we want to eliminate the special axle and adopt the standard axle in connection with car lighting, that is a subject of recommended practice and letter ballot. I would, therefore, add to the motion that the question of eliminating the special axle, and the adoption of the standard M. C. B. axle in connection with car lighting, be referred to letter ballot covering these points.

Mr. Sloan: We did not have a special axle. We say if you use it, make it thus and so, so that when you get your pulley bushing on it will conform to the same bushing as the M. C. B. axle, and hence will be interchangeable.

Mr. Davis: I was chairman of the Train Lighting and Equipment Committee in 1917, and we made a special effort to steer clear of special axles, and I don't think you will find a thing in any of the reports of the committee which requires a special axle. If the Committee on Standards should see fit to eliminate the special axle shown, there certainly will be no objection on the part of the Car Lighting Committee.

B. B. Milner (N. Y. C. Lines): I believe that the interests of the Association and the interests of the railroads are somewhat broader than as stated by Mr. Sloan, and it seemed to me that some action should be taken in connection with the elimination of the special axle. As a matter of information, I would like to ask Mr. Sloan how many cars are carrying these special axles.

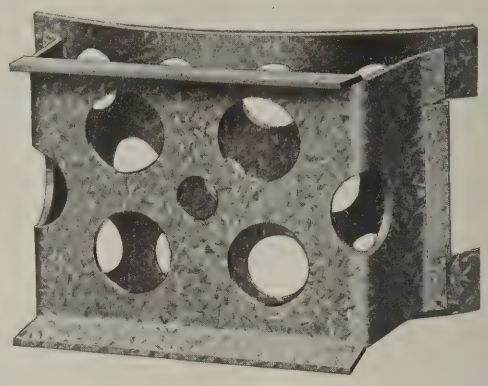
Mr. Sloan: The committee cannot state how many roads or how many cars are using special axles. We considered that the axle was out of our province, and what we considered our duty was to report on the conditions whereby we could make the pulleys interchangeable.

C. B. Keiser (Penna. Lines): It seems to me that the axle has nothing to do with this. The committee stated that it made the pulleys interchangeable so that you could use either the standard axles or the special axles, as you pleased.

Mr. Gaines' motion, with the addition, regarding the special axle and adoption of the M. C. B. axle was then put to vote and carried.

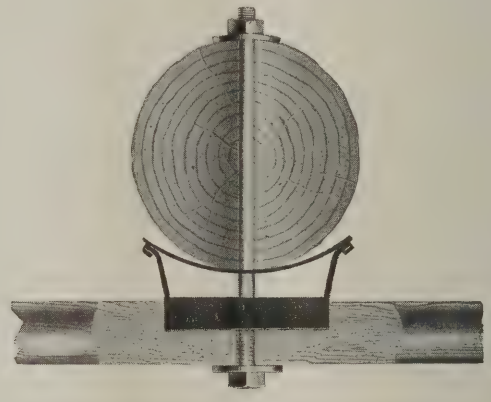
AN IMPROVED TYPE OF STEEL GAIN

The Hallett Steel Gain has been redesigned to eliminate the projecting metal parts, which, on the former device, cut into the pole to prevent turning. The new design accomplishes the same purpose by gripping the pole. This gain has been developed to eliminate the cutting of a gain in the outer fibers of the pole. When used this gain is placed between the cross arm and the pole and by means of a through bolt, of the proper length, it is held in place and also supports the cross arm. The improved type consists of a pole plate with a radius larger than that of the pole, and a gain plate of galvanized steel. Tightening up on the through bolt causes the struts on the gain plate to press against the pole plate in such a manner as to cause the pole plate to shape itself about the pole. It is claimed that the improved gain grips the pole sufficiently to permit the weight of a lineman at the end of a five-foot cross arm without producing any visible signs of deflection. The size of gain depends upon the vertical dimension of the cross arm and, to some extent, upon the diameter of the pole. A gain fitting a pole 6 in. to 8 in. in diameter will fit those of larger diameters,



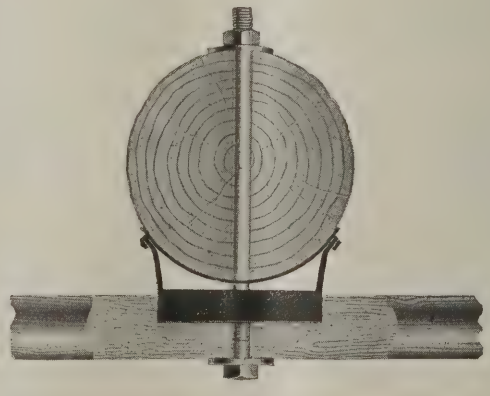
The Pole and Gain Plate.

but in order that the distance between the pole and arm may not exceed ½ in. when the through bolt is tightened, gains are made for poles from 6 to 8 in., 8 to 10 in. and over 10 in. in diameter. The distance between the pole



Steel Gain Before Tightening Through Bolt.

plate and the gain plate is ¾ in. before the gain is applied. After application when the bolt is tightened this distance varies between ⅛ in. and ⅜ in., for each of the various



Steel Gain After Tightening Through Bolt.

sizes, depending upon the size of pole to which a particular size of gain has been applied. The illustrations show this gain, which is manufactured by the Hallett Iron Works, Harvey, Ill.

Telegraph and Telephone Division Meets

Pole Line Construction, Wire Crossings and Electrolysis Among Important Subjects

THE telegraph and telephone division of "Section 1—Operating," of the American Railroad Association, formerly the Association of Railway Telegraph superintendents, held its first annual meeting at the La Salle Hotel, Chicago, on June 11, 12 and 13. The former association held its thirty-seventh meeting at Chicago on June 10, at which time the old association was disbanded to become a division of the A. R. A. Martin H. Clapp, manager of the telegraph section of the United States Railroad Administration and chairman of the division, presided. The total registration included 123 active and 45 affiliated members, which was a much larger attendance than for the annual meeting of the former association held at Chicago, on December 5 and 6 of last year.

The chairman, in his opening address, pointed out the new conditions under which the old association must now work. He stated that although the reorganization was intended to be only for the duration of federal control, he felt it was for the best interest of the members, and believed the amalgamation will be permanent. In outlining future work, he stated that unfinished reports would be completed and that supplemental specifications would be drawn up to accompany finished specifications, as for instance supplemental specifications for materials, and that the committee of direction should lay out work to extend over a period of several years. He also pointed out the necessity of co-operation in and between different departments of railroad and commercial companies in order to obtain the best results.

R. H. Aishton, regional director, northwestern region, United States Railroad Administration, delivered a short address before the Thursday morning session. He said in part that wonderful progress had been made by various associations in the past, and that the history of the last few years indicated what had been accomplished. In 1908 there was only one telephone circuit for train dispatching in the country. It was 45 miles long and was in service on the Chicago, Burlington and Quincy. At present there are 13,440 miles of such circuits. Mr. Aishton stated that he is a firm believer in association work because the members of various associations have practical knowledge of their particular specialties which is of value to the railroads. This class of men is better equipped than any one else to prepare recommendations and standard practices. He felt that it was a wise move of the association in becoming part of the American Railroad Association; the railroads will, of necessity, have to look to somebody for information after their return to private operation, and he felt that no railroad would be foolish enough to go contrary to recommendations of such an association as the American Railroad Association. If the roads go back to private operation at the end of the year it will be under changed and better conditions, and greater progress will be made during the next few years than ever before.

Pole Line Construction

Sub-Committee A, Maintenance and Construction of Pole Lines of Committee No. 1, Construction and Maintenance, Outside Plant, presented a preliminary draft of pole line specifications including 15 of the proposed 16 sections, but in general without the official drawings and without certain appendices yet to be decided upon. A plan for pole line specifications involving complete independence of any other organization or company was presented at the annual meeting held in Chicago last December. It was decided, however, to develop through joint action if possible uniform specifications satisfactory to both railroad and telegraph interests, and this report was made upon that basis. Railway electrical engineers and others engaged in work of that character will be interested in the following paragraphs of the report:

B-10 Clearance from Power Lines.—Telegraph and telephone lines paralleling electric light or power lines shall, where practicable, have a horizontal separation from the power line not less than the height of the poles in the taller line. Where this separation cannot be obtained, special construction will in general be required for the power line, and also for the telegraph or telephone line when its wires are at the same or higher level than the power wires. For power line construction in such situations, see standard specifications for power line construction in conflict with telegraph and telephone lines. The special construction for telegraph and telephone lines is covered in Section R, Foreign Wire Crossings and Parallelisms. (Not included in report).

B-11, 12, 13 and 14 Clearance from Electric Light and Power Conductors.—At all crossings or parallelisms between power lines and telegraph or telephone lines the following clearances shall be maintained between the wires and cables of a telegraph or telephone line and the wires, cables, guys, messengers and span wires of electric light or power lines:

Power line voltage 0 to 7,500 volts.....	4 ft.
Power line voltage 7,500 to 50,000 volts.....	6 ft.

At a power line crossing if the span length of the line which is at the higher level exceeds 150 ft. the clearance given above shall be increased 1 in. for each 10 ft. excess thereof.

Where the voltage of a power line exceeds 50,000 the 6 ft. clearance specified for lines from 7,500 to 50,000 volts, shall be increased ½ in. for each 1,000 volts excess.

Where a power line crosses over a telegraph or telephone line and the conductors of the power line are supported by suspension insulators, the clearance shall be increased so that the breakage of a conductor in either adjoining span would not cause the clearance to be reduced to less than three-fourths of that specified above.

B-15 and 16 Clearance from Trees and Buildings.—A clearance of at least 4 ft. from trees and underbrush should, where practicable, be provided for all wires and cables. The clearance shall never be less than 2 ft.

No wire or cable should be carried nearer than 2 ft. to any building, bridge or other structure unless attached thereto.

B-17 Clearances on Jointly Used Poles.—When telegraph or telephone conductors are carried on the same pole with electric light or power conductors, the telegraph or telephone crossarms shall be spaced at least 4 ft. (center to center) from the electric light or power crossarms. Lines for the joint use of power conductors and telegraph or telephone conductors shall, in all cases, be in conformity with standard specifications for such joint use.

D-10 and 11 Size and Spacing of Poles in Lines Paralleling

Power Lines.—The normal size and spacing of poles may be employed where a telegraph line parallels an electric light or power line with a separation greater than the height of the poles in the taller line, or with its wires at a lower level than those of the power line.

For the construction of telegraph or telephone lines which parallel power lines with a small separation and with their wires at the same or a higher level than the power wires, see Section R, Foreign Wire Crossings and Parallelisms. (Not included with the report.)

The committee after presenting the report asked for the approval of the plans submitted for the several grades of construction and the principles of their application and also for further instructions to proceed in future development work.

E. C. Keenan, general superintendent of telegraph, Eastern regions, United States Railroad Administration, presented a reply to the preliminary draft and specifications for the construction of pole lines in which he pointed out the advisability of the committee establishing a set of specifications based on engineering principles and in concluding his remarks he offered an amendment to the original motion to the effect that the committee should continue along lines consistent with principles heretofore adopted by the Association of Railway Telegraph Superintendents and proposed that certain tables be revised so as to conform to the grades and specifications submitted in his paper.

William Bennett, superintendent telegraph, Chicago & North Western, felt that it was unnecessary for the committee to follow engineering principles in pole line construction as strictly as followed the other items of railroad construction, railroads can operate temporarily with a failure due to storms; the important factor at such times is to keep the tracks clear and the interlocking switches, frogs, etc., open for the movement of traffic.

Wire Crossings

Sub-committee B.—Wire Crossings, Committee No. 1 Construction and Maintenance, Outside Plant submitted a report which covered its criticisms of the preliminary report prepared by the Bureau of Standards of proposed revisions of section 28 of Circular 54 covering signal lines crossing over railways. The matter of interest to railway electrical engineers and others similarly engaged was given in the report as follows: It is the intention, that sub-committee B shall, as soon as the Bureau of Standards finally issues its revision of section 28, get up detail specifications for wire crossings over railroads as well as parallels or conflicts between signal lines and power lines. Following the presentation of the report by the committee it recommended that the report be accepted by the association and that it be instructed to proceed along the lines they were working with the understanding that they follow good engineering practice and the recommendations of the Bureau of Standards and Wire Crossing Companies. Discussion followed this motion which dealt largely with the question of wire crossings over important and non-important railways. Such a division of wire crossings apparently is the attitude of the Bureau of Standards. The committee, and also the association, felt that there were no unimportant railways as far as wire crossings are concerned.

Protection Against Electrolysis

Committee No. 3 submitted a revised and final form of its report of 1916 consisting of a general discussion of electrolysis affecting cables, its nature, causes, remedies, methods of detecting the existence of electrolytic action and of eliminating it or mitigating its severity. It also submitted descriptions of instruments and other apparatus for making electrolytic tests and instructions concerning their use, and certain specific maintenance instructions.

The following is an abstract of the committee's report which is of interest to railway electrical men:

Protection of cables against electrolysis really begins with the possible sources of injury to conduit materials and cables along the proposed route of a new duct line. Soils having a large moisture content and those containing cinders, or acids, alkalies or dissolved salts in large proportions are objectionable. In these soils stray currents are favored and electrolysis and "self-corrosion" are likely to occur. Dry porous soils are more favorable to protection. Brackish or salt water is extremely unfavorable.

Street railway tracks and iron pipe lines near and parallel to the route of the proposed cable are undesirable and if a street so occupied adjoins one side of the right of way the conduit preferably should be placed on the other side.

Choice of conduit material is governed largely by the physical requirements and costs. Of the materials now commonly used, none is thoroughly effective either in insulating the cable or excluding moisture. The same may be said of various coatings intended to effect these purposes. In most cases cables contained in iron pipes are fairly free from electrolysis, the pipe and not the cable is subjected to the corrosion. The extensive use of iron pipe in underground systems is prohibited by its high cost. The use of short sections should be limited to cases of necessity. The principal precaution in the use of other materials concerns their quality. Specifications for creosoted wood duct should so control the treatment that the creosote will be free from acids or other corrosive agents. When ducts are built in concrete or where seepage from concrete structures can get into them, corrosion from free lime or other alkalies may occur.

The electrolysis of cable systems occurs through electrical contact between the sheath of the cable and moist soil. There are very few cases where the great expense and special precautions needed to insulate cable sheath from the soil can be justified and then only when a comparatively short length is to be dealt with.

Cables should be neatly arranged and supported on racks in manholes and should not be permitted to lie on the ground or floor of the manhole. When two or more cables occupy the same duct system the cables should be bonded together at each manhole. Where cables enter buildings, or are carried upon metal structures or up poles, special precautions must be taken to provide ample separation from metal which may serve to introduce current to the cables or to lead it away. In such situations insulating joints in the cable sheaths or special methods of supporting will sometimes be advisable. Lead covered cables should never be buried in soil.

When cables are laid in conduits that have not previously been occupied and there is reason to expect that electrolysis may be serious, it is necessary sometimes to make preliminary electrolysis surveys before the cable installation is completed. The sheaths of the sections of

cable should be electrically connected together temporarily with copper wire as they are placed in the ducts and before splicing. Tests should be made from time to time as sections are added. When thus temporarily connected, the results of the tests are equivalent to those which would be obtained after splicing.

Aerial Cables

When aerial cables are loaded by means of coils in buried loading pots, the continuity of the sheaths should be broken between the aerial cable and the loading pot, and the cable protected at this point by means of an approved insulated sleeve. Where aerial cables connect to short sections of underground cables, such as crossings under extra high potential lines, breaking the continuity of the sheath between the aerial cable and the underground cable will depend upon the special conditions in each case.

Where it is undesirable to break the continuity of the sheaths, or where it is necessary to make the sheaths continuous to reduce inductive disturbance, or to utilize the sheath of the aerial cable as part of a current drainage connection, the aerial cable should be considered, from the standpoint of electrolysis, as an underground cable, and subjected to the same periodical tests.

Maintenance

Protection against the damaging effects of electrolysis is a prominent feature of the maintenance of cables, involving methods of watching for electrolytic attacks upon them and the adoption of prompt measures to determine their extent, causes and remedies. Periodical examinations of the cable plant should be made at intervals corresponding in length to the known degree of general hazard, both to determine the physical condition of the plant, such as drainage of water, support of cables, condition of heads, splices and terminals, and to make the simpler tests depended upon to reveal the presence of foreign currents using the system as a path.

Persons who have direct charge of or perform the work of maintaining cables, should have experience in using the simpler apparatus for testing and this experience should be acquired under the direction of experts; otherwise it would be unsafe to depend upon their inspection reports. It is not desirable that they should make tests with instruments until it has been demonstrated that they know how to obtain correct results when using them.

Causes and Effects of Electrolysis

Electrolysis is defined as the process of producing chemical decomposition through the direct influence of electricity. Electricity enters the electrolyte from the surfaces of electrodes of metal or other good conductors and the chemical decomposition which it produces may take the form of breaking up one or more of the substances of which the electrolyte is composed or of a breaking up of those substances accompanied by a solution of metal of an electrode. The electrolytic corrosion of lead sheathed cable systems and of other subsurface metallic structures is mainly concerned only with one of these possible manifestations of electrolysis, viz., the dissolving of a metal electrode. At the same time this corrosion is produced, a directly associated decomposition of some substance dissolved as an electrolyte is also going on, and although the details of this latter decomposition are not often of much interest to those concerned with the electrolysis of subsurface metallic structures, its occurrence should not be entirely forgotten.

Soil when entirely dry and free from any content of water practically does not conduct electric current. The natural occurrence of such dry soil, however, is very rare and as nearly all soils contain more or less moisture, they are almost universally electrolytic conductors. Concrete containing moisture is likewise an electrolytic conductor.

The extent of electrolytic decomposition which occurs is dependent upon the quantity of electricity passing through the electrolyte, that is, the mass of a metal corroded by electrolysis in a given time depends only on the current, and with the current densities and other conditions usually found in practice, where subsurface metallic structures are to be dealt with, is usually equal to the amount called for by Faraday's law. The applied voltage has no direct effect on the corrosion except as it may determine the current strength and there is no minimum voltage below which electrolysis cannot occur.

Electrolysis is one of the results of the passage of stray current through the earth. Lead sheathed cable systems, gas or water pipe networks and other extensive subsurface metallic structures often afford paths of much greater conductivity than the neighboring soil. Such conducting systems, if present in the neighborhood of electric railways, collect and carry for appreciable distances large portions of the stray currents. Unless these systems have direct metallic connection with the negative bus-bar of electric railways the stray current must leave them to make its way back to the source of supply. At these points of departure the current which has passed from the soil to some other section of the structure must pass from the structure to the soil. When current passes from the structure to the soil, to return by some route to the negative bus-bar, the structure is the anode of an electrolytic cell and suffers from anodic corrosion.

Lead shows relatively high resistance to corrosion from most of the solutions found in the soil. It is, however, very susceptible to attack by alkaline solutions. This characteristic sometimes results in the corrosion of cable sheaths at points where stray current is received from the soil, i. e., where the lead sheath is the cathode of an electrolytic cell. At these points the passage of current causes electrolytic decomposition and the accumulation of alkaline substances in the neighborhood of the sheaths. When current ceases to flow, as may happen through a reduction in the frequency of car service or through the stoppage of service at night, the alkalies are free to attack the lead sheath and can produce, as a secondary result of stray current, the corrosion of cable sheath at points where it is most of the time the cathode of an electrolytic cell. It will therefore be seen that the presence of stray current from electric railway systems is the usual cause for the electrolysis of lead cables and the electrolytic corrosion of the cable sheath which results from the flowing of this stray current is deteriorating the protective armor of the insulated cable conductors. If the corrosion of the cable sheath is unchecked the ultimate result is the exposure of the insulated conductors to moisture and a termination of the serviceability of the cable thus damaged.

Electrolysis Surveys

The systematic examination of a cable system, often called a "potential survey," although it usually includes other work in addition to measurements of voltage, is the principal means for ascertaining whether a cable system is being affected injuriously by electrolysis. Such surveys are required not only initially, to determine whether the cable needs protection from electrolysis, but also periodically throughout the service life of the system to insure that it still continues to be free from any electrolytic injury.

Assurance of freedom from electrolytic injury can only be had when it is known that there is no stray current passing from any point on a cable system to the soil. The most effective means of determining whether stray current is passing from a particular cable sheath to soil is to determine the direction of any potential difference that may exist between the sheath and a small isolated piece of the same material in contact with the soil in a position adjacent to the cable. Where the sheath is found to be positive to this testing electrode it is generally to be assumed that current is flowing from the sheath to the soil since the only condition under which current flow would not occur would be one where the cable sheath was effectively insulated from the earth. Observations of potential differences to nearby rails, pipes and other subsurface metallic structures, and observations of fall of potential along the sections of the cable sheath, can also be made in connection with this measurement of potential difference to soil and will serve to throw light upon what the stray current is doing. When measurements of this character have been made at all parts of a cable system and show that no current is flowing from the cable sheath to soil and that no excessive amount of stray current is flowing from the soil to the sheath it may safely be concluded that the cable system is not undergoing electrolytic corrosion. If contrary indications are found, it is necessary to conclude that electrolytic corrosion is taking place and to adopt measures which will serve to mitigate its effects.

Deductions to Be Made from the Surveys

When the survey of a cable system indicates that at some point current is flowing from the cable sheath to the soil, it is necessary to adopt some protective measure which will prevent the continued corrosion of the cable. The principal measure which can be employed to protect lead sheathed cables from electrolytic corrosion is the current drainage connection. As the name implies, the function of this device is to drain the stray current from the cable in such a manner that no current will pass from the cable sheath to soil. The final test of the effectiveness of a drainage connection is that the cable shall continuously test negative to soil, as such a condition will show that stray current is at all points flowing to the cable and at no point flowing away from the cable. While the installation of a drainage connection is not the only measure which can be employed for the protection of cables, one such connection is almost always necessary for any cable system exposed to electrolysis and alternative measures find application only in special cases. The work connected with the design and installation of a drainage connection will therefore first be discussed.

It is generally considered best to run the drainage connection either to the bus-bar of the power house or substation from which the stray current is derived or to a negative feeder directly connected with this bus-bar. Occasionally connections can be run to the rails of the street railway, but only when the standards of track maintenance are high, as when rail joints are open a connection with the rails is likely to endanger the cables rather than to protect them. In any case the point on the railway power system to which the drainage connection runs must be at a potential sufficiently low to enable it to draw current at all times from the cable system.

In some cases connections to ground plates can be employed in place of a drainage wire connection to the electric railway return circuit. Ground plates are limited in application to situations where only a small amount of current is to be removed to make the cable negative, and where large expense would be involved in establishing a drainage connection. The function of the ground plate is the same as that of the drainage connection, viz., to drain stray current from the cable, but the ground plate suffers from corrosion since the current drained from the cable has to escape to the earth from its surface.

Testing Apparatus

The portable measuring instruments required in electrolysis work include voltmeters, millivoltmeters and ammeters. Separate instruments of each kind can be carried, but it will usually be found more convenient to employ the special portable instruments which have been designed particularly for this work.

Instruments used for making electrolysis tests should have the zero in the center of the scale and should have a resistance of not less than 150 ohms per volt and preferably 400 or 500 ohms per volt. To meet all conditions which may be encountered, it is common practice to provide two or more ranges in each meter.

For potential measurements, voltmeters having ranges of 5-0-5 and 50-0-50 volts are very satisfactory. Another equally good combination consists of ranges of 1.5-0-1.5, 15-0-15 and 150-0-150 volts.

One of the combinations of ranges that is best suited for making millivoltmeter measurements consists of 5-0-5, 50-0-50 and 500-0-500 millivolts. Another good combination is 10-0-10 and 100-0-100 millivolts.

For the sake of economy in the purchase and use of instruments, it is customary to purchase combination instruments which are both voltmeters and millivoltmeters; also to provide either ammeter terminals or ammeter shunts, which make the instrument suitable for measurements of current.

Connecting Rods

For making connections to cables, earth, rails, etc., light wooden rods equipped with metal tips, and flexible conductors for connecting to the instruments, should be provided. Two of these testing rods may be conveniently carried at all times. The rod used for making contact with cables or rails may have a tip of any suitable metal, such as steel, brass, copper or lead. The rod used for making contact with the earth should have a tip of the same kind of metal as that whose potential is to be measured; that is, a piece of lead cable sheath if testing lead sheath cable, a piece of steel if testing rails, etc. For making millivoltmeter measurements on cables, it is not necessary that two rods having tips of the same kind of

metal should be used. The metal on the tips of all rods should be kept clean and bright and care should be taken to remove rust and other products of corrosion from the points on the surface of the structure against which the metal tip presses so that a clean, bright surface will be available for the contact.

Installation of Drainage Wires

Drainage wires should be installed so that they will not be in contact with any grounded metallic structures, except at the point of connection to the cable sheaths and the negative return system of the trolley company. Bare wire may be used where drainage wires are run aerially, or where they are placed in a subsidiary duct built for the purpose, between the underground cables and a nearby pole, or to the trolley return system in a nearby subway. If drainage wires are run underground for any considerable distance, the wires should be covered with a waterproof insulation.

Every drainage wire should be fused between the point where it is attached to the cable sheath and the point where it is attached to the negative return system of the trolley company. The fuse should be placed either in the railroad manhole near the top of the hole, or (where the drainage wire is run aerially) in a suitable box on the subsidiary pole.

A non-arcing fuse should be used, and where this fuse is placed in a manhole, the manhole should be ventilated. The current capacity of the fuse should be about 25 per cent greater than the maximum normal current which the drainage wire is to carry.

TABLE FOR DETERMINING CURRENT ON LEAD CABLE SHEATHS FROM VOLTAGE DROP IN MEASURED LENGTH OF SHEATH

Resistivity, 1 ft. length 1 sq. in. sectional area—0.00010 ohm

Outside diam. of lead sheath (In.)	Thickness of lead sheath (64th in.)	Resistance of lead sheath (Ohm per ft.)	Current for 1 millivolt per ft. (Amp.)	Outside diam. of lead sheath (In.)	Thickness of lead sheath (64th in.)	Resistance of lead sheath (Ohm per ft.)	Current for 1 millivolt per ft. (Amp.)
0.50	4	0.001163	0.860	1.625	6	0.0002218	4.51
0.50	5	0.000965	1.036	1.625	7	0.0001920	5.21
0.50	6	0.000836	1.196	1.625	8	0.0001698	5.89
0.625	4	0.000906	1.104	1.75	6	0.0002051	4.88
0.625	5	0.000745	1.343	1.75	7	0.0001772	5.64
0.625	6	0.000640	1.563	1.75	8	0.0001567	6.38
0.75	4	0.000741	1.350	1.875	6	0.0001906	5.25
0.75	5	0.000606	1.650	1.875	7	0.0001648	6.07
0.75	6	0.000518	1.931	1.875	8	0.0001456	6.87
0.875	4	0.000627	1.594	2.00	6	0.0001781	5.61
0.875	5	0.000511	1.957	2.00	7	0.0001538	6.50
0.875	6	0.000435	2.300	2.00	8	0.0001359	7.36
1.00	5	0.0004419	2.263	2.125	6	0.0001672	5.98
1.00	6	0.0003750	2.668	2.125	7	0.0001443	6.93
1.00	7	0.0003268	3.061	2.125	8	0.0001273	7.86
1.00	8	0.0002913	3.437				
				2.25	6	0.0001575	6.35
1.125	5	0.0003892	2.569	2.25	7	0.0001359	7.36
1.125	6	0.0003294	3.037	2.25	8	0.0001198	8.35
1.125	7	0.0002866	3.491				
1.125	8	0.0002547	3.926	2.375	6	0.0001488	6.72
				2.375	7	0.0001284	7.79
1.25	5	0.0003476	2.876	2.375	8	0.0001132	8.83
1.25	6	0.0002939	3.404				
1.25	7	0.0002552	3.918	2.50	7	0.0001217	8.22
1.25	8	0.0002265	4.415	2.50	8	0.0001073	9.32
				2:50	9	0.0000959	10.43
1.375	5	0.0003142	3.183				
1.375	6	0.0002650	3.773	2.625	7	0.0001156	8.65
1.375	7	0.0002299	4.35	2.625	8	0.0001019	9.81
1.375	8	0.0002038	4.91	2.625	9	0.0000911	10.98
1.50	6	0.0002416	4.14				
1.50	7	0.0002092	4.78				
1.50	8	0.0001853	5.40				

Aerial Cable Sheath as Part of Drainage Connection

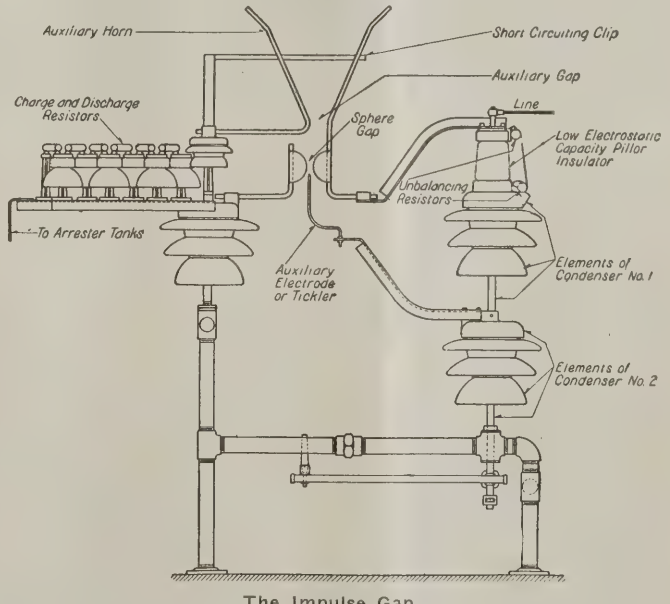
In certain cases, it may be found advisable to make use of the sheaths of aerial cables as part of a drainage connection between underground cables and negative returns of trolley systems. Where this is done, a fuse should be placed in the bond between the aerial cable sheath and the underground cable sheaths, and between the aerial cable sheaths and the drainage wire connection. The aerial cable should always be bonded to the messenger strand at the point where connection is made to the underground cables, and where connection is made to the drainage wire. Where the length of the aerial cable is greater than ten pole sections, the sheath of the cable should be additionally bonded to the messenger strand.

Following the report of the committee it was moved that the report be accepted as recommended practice. After very little discussion the motion was carried.

IMPULSE GAPS FOR ARRESTERS

Impulse gaps used in connection with lightning arresters protecting stations of large capacity, operating at 11,000 volts and higher, give protection from lightning and other high-frequency or high-voltage disturbances. The impulse gaps, shown in the illustrations, are for use in connection with electrolytic or other three-phase (grounded or ungrounded neutral circuit) lightning arresters now in service.

The old-fashioned plain horn gaps had considerable time-lag, allowing a high-frequency surge to rise to a much higher voltage than would a low-frequency surge before discharging and giving protection. The development of the sphere gap partly prevents this situation by eliminating the time lag so that all frequencies are discharged at the same voltage. A new impulse gap, produced by the Westinghouse Manufacturing Company, Pittsburgh, has a negative time lag; that is, the higher the frequency the lower the voltage at which the gap discharges. Thus the impulse gap automatically selects the dangerous surges and gives protection more quickly.

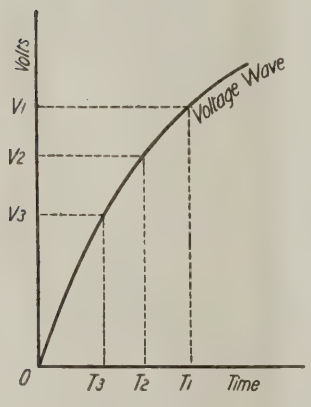


The Impulse Gap

The impulse gap not only incorporates all of the virtues of the horn gap and the high-speed sphere gap, but also possesses the property of selecting high-frequency or steep-wave-front surges, discharging them at a lower voltage than the normal voltage setting of the gap. It

should be particularly noted that the impulse gap protects insulation against a steep-wave-front surge of reverse potential, that is, a sudden drop in voltage. The high-frequency discharge voltage may be as low as two-thirds, or even one-third, of the normal-frequency value. It is, therefore, possible to use a gap setting that will permit of the desired degree of protection against dangerous surges while not permitting too frequent discharging on minor surges at normal frequency.

The high speed of the sphere gap as compared with the horn gap is due to the elimination of the time required to build up a sphere of equal-potential surface at the discharge part of the horn gap. The sphere of the sphere gap tends to eliminate corona and reduces field distortions when the gap is set equal to, or less than, the sphere diameter. By the use of the sphere gap the voltage to ground, or the break-down voltage, at any frequency does not materially exceed the 60-cycle discharge voltage of the gap. However, the sphere gap does not give the desired protection against steep-wave-front, or high-frequency surges, due to its inability to discharge these disturbances at lower voltage than the normal frequency setting of the gap. It is necessary to set all arrester gaps for a sufficiently high normal frequency break-down voltage so that they will not discharge too frequently on comparatively harmless low-frequency switching surges. The impulse gap, however, has the advantage that this high normal-frequency setting of the gap can be had without the corresponding disadvantage of reduced protection, since the high-frequency break-down value of the gap is much lower. This is because high-frequency discharges start from the auxiliary electrode and have only ½ of the gap to jump. The latter electrode is so shaped that, although the gap is ½ of the



High Voltage Wave

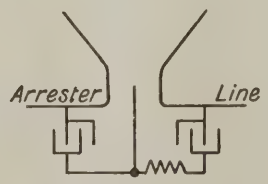
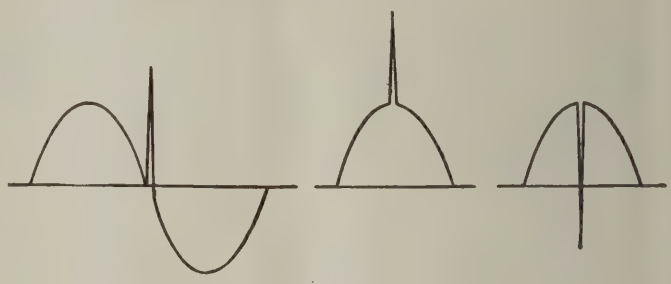


Diagram of Gap

main gap, the break-down voltage is only about ¼ as great; that is to say, high-frequency surges not only are not delayed in discharging, as is the case with plain horn gaps, which require the building up of a static field, but instead, discharge at a voltage even lower than the normal value of the main gap, since they automatically select the auxiliary gap of a much lower voltage break-down This is shown graphically in the accompanying illustration. V_2T_2 represents the point and time of break-down of a properly designed sphere gap which has no time lag. V_1T_1 shows the delay resulting from the time lag of an ordinary horn gap and the consequent greater rise of voltage before the discharge takes place. V_3T_3, on the other hand, shows the earlier discharge and the quicker and better protection resulting from the lower voltage break-down of the impulse gap due to its selective property.

The impulse gap uses a circuit that, at normal frequency, is balanced as to voltage, but becomes unbalanced and starts a discharge in the case of any high-frequency surge. At normal frequency there is no difference of potential between the mid-point of the condensers and the auxiliary electrode midway between the auxiliary horn and sphere gap. A high-frequency, however, passes freely through the condensers and piles up its full voltage across the resistance, that is, across one-half of the total gap. This gap, therefore, breaks down, resulting in the total voltage being impressed on the remaining gap, which breaks down in turn, dissipating the disturbance to


Impulse Voltage Super-Imposed on 60-Cycle Wave

ground. The break-down of each half of the gap is facilitated by the fact that the auxiliary electrode is small in size (having needle gap characteristics), so that the discharge voltage of each half of the gap is about ¼, rather than ½, of that of the total gap between the spheres. It should be especially noted that the danger to apparatus from steep-wave-front surges, particularly of reverse potential, may be out of proportion to their actual magnitude, due to the inductance of apparatus, which not only produces a high voltage across the first few turns of the winding of any apparatus, but also a much higher voltage to ground than the normal voltage of the impulse, due to the addition of induced or reflected voltage to the normal voltage of the impulse. If the apparatus is to be protected with a gap and lightning arrester, the gap should be one that will select and discharge the high frequency disturbances at a voltage lower than normal.

The necessity of selective action in the gap is emphasized by the following possible combinations, as shown, of the impulse and line voltage. (Assume that an ordinary sphere gap to ground is set to discharge at twice the line voltage.)

Case A—The voltage of the line does not affect the action of the impulse, and the impulse must reach twice the line voltage before the gap will discharge.

Case B—The voltage of the impulse must reach only the same voltage as that of the line, before the gap discharges.

Case C—The voltage must have a value three times the line voltage before the gap discharges. In this case, it is to be noted that conditions are such that the high-voltage stress is present not only to ground, but also between turns of windings of apparatus. Adequate protection against this condition requires the use of a gap which is very sensitive to steep-wave-front surges. If the impulse is oscillating the second half cycle may cause a discharge, but the time for protection against the destructive effect of the first half cycle will have passed.

Railroad Electrification Facts and Factors

Methods of Installing Fuses For the Protection of the Locomotives Against Excessive Current

By A. J. Manson*

IN the previous article we discussed fully the construction and design of the third-rail shoe and outlined how these shoes are mounted on the third-rail shoe beam. In this article we will take up the method used in conducting the electric current from the shoes to the control apparatus.

The current is taken from the third-rail shoes into the locomotive by means of electric conductors or cables. These cables do not pass directly into the locomotive, but connect to a fuse box, which may be mounted on the third rail shoe beam just above the shoes, or on the truck or body of the locomotive. The function of the fuse box is protection. It is placed in the circuit, so that if an abnormal current passes through the fuse, due to a short circuit or breakdown of the main cables and apparatus, the fuses will blow and the power will be cut off. Damage to the locomotive will thus be prevented. In general,

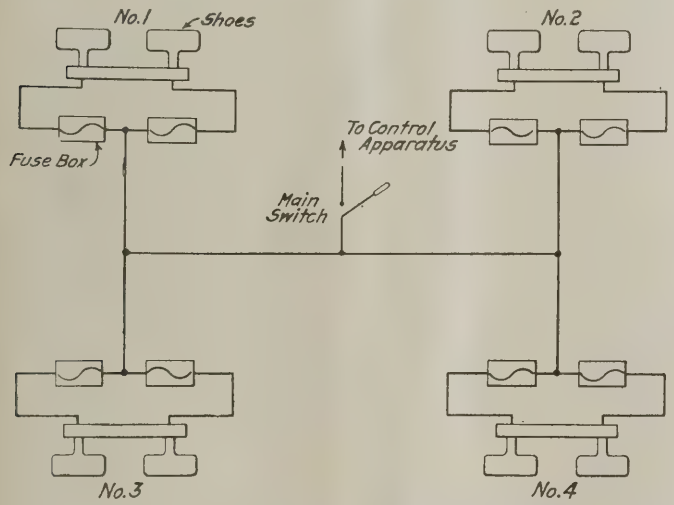


Fig. 1—A Simple Method of Locating Fuses, but one that necessitates the use of fuses of large capacity and thus reduces protection

the fuse box is placed as close to the shoes as practical, thus cutting down to a minimum the length of unprotected cable, that cable between the fuse box and the shoes.

Generally there are four sets of third rail shoes mounted on the locomotive, two on either side at the ends of the locomotive. The object in placing them at the ends is to get them far apart, so as to breach as many gaps in the third rail as possible. We have previously mentioned that gaps in the third rail must occur, at cross-overs, intersections, switches, etc., since it is impossible to carry the third rail as a continuous conductor. The locomotive must coast over these gaps. With the third rail shoes spaced at the maximum distance, the time which occurs from the breaking of contact on the rear shoe to the making of the contact on the forward shoe, is reduced to a minimum.

*Westinghouse Electric and Manufacturing Company, New York.

There are two general schemes used to connect up the shoes with the fuse boxes and the main conductor leading to the main switch. The first arrangement is that shown by Fig. 1 and the other arrangement is that shown by Fig. 2.

In the arrangement as shown by Fig. 1, if the locomotive is starting up with say, only the No. 1 pair in contact with the third rail, or say that the No. 2 pair had been broken off, due to hitting some obstruction along the track, and that the third rail was on that side of the locomotive, then all of the current required by the locomotive must be taken through the two fuses which are connected in parallel. The fuses must have sufficient capacity to carry this normal current without blowing. Normally, however, both sets of shoes on one side are in contact with the third rail and are collecting current. Since all fuses are necessarily of the same capacity, with two sets of shoes collecting current, it means that there is really twice as much fuse capacity as necessary.

The scheme shown by Fig. 2 is different. The sets of third rail shoes on the two sides of the locomotive are interconnected, so that when one shoe is in contact with the third rail, all other shoes are "alive," and the fuse boxes are arranged so that they all are in the circuit. In other words, the electric current taken by the locomotive is drawn through all the fuse boxes on the locomotive, even if only one set of shoes is in contact with the third rail.

With this arrangement, the fuse used in the fuse box can be of much lower capacity than if all the current is taken by the locomotive through one fuse, or in some cases two fuses in parallel.

For instance, assume that the current taken by the locomotive is 6,000 amperes. Under the condition of one set of shoes only touching the third rail, the capacity of the fuse would have to be in excess of 6,000 amperes and of sufficient capacity to handle this current for the period of time that the locomotive would require to start up a heavy train and until the second set of shoes on the same side comes in contact with the third rail. By connecting in the fuse boxes on the opposite side of the locomotive from the set of shoes in contact with the rail, the current drawn by the locomotive is divided among the fuse boxes. If four of these were in parallel handling this current, then 1,500 amperes would be the amount passing through each fuse. Therefore, a fuse of say 2,000 amperes capacity could be used instead of one of say 8,000 amperes, if a single fuse box was used, or 4,000 amperes if two boxes in parallel were used as shown in Fig. 1. When both sets of shoes on the one side are on the third rail, in the first scheme, Fig. 1, 16,000 amperes would have to flow before the fuses would blow, and the protection afforded by the fuses is cut down materially. No larger fuse than is necessary should be used, so that in case of trouble, the fuses will blow immediately, thus removing current from

the locomotive and preventing excess damage. The second scheme is shown by Fig. 2. The four sets of shoes are shown. The fuse boxes are shown as *a, b, c, d, e, f, h* and *i* and are connected up with the third-rail shoes and with each other, as shown by the cable connections *m, n, o* to *y* and *z*. With this arrangement, the current taken by the locomotive through the lead *z* passes through four fuse boxes, namely *b, c, f* and *h*, regardless of whether one set of third-rail shoes or more are in contact with the third rail. Referring to Fig. 2, the No. 1 set of shoes is in contact with the third rail. The flow of the electric current through the cable is then as follows: Current passes up through the cable n, part going through the fuse *b* along the cable *p* and hence through *y* to *z*. Current also passes along the cable *q* to the fuse box *f*, through same, and hence to cable *y* and to cable *z*. The current which passes up the cable (*o*) from the third-rail shoes, goes through fuse box *a*, hence to the other

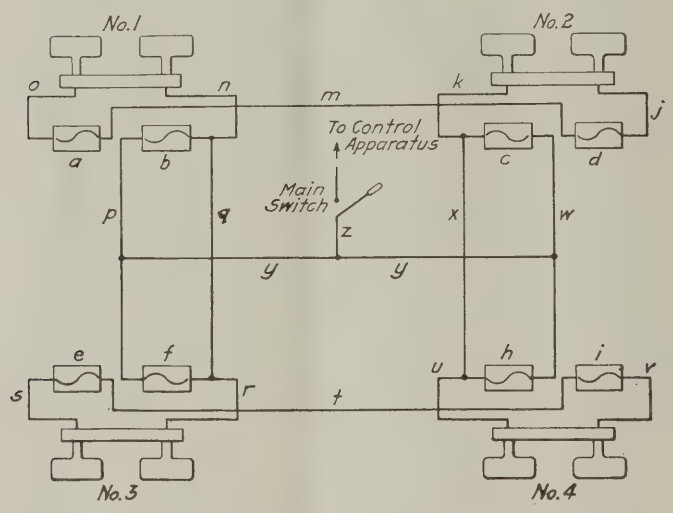


Fig. 2.—This scheme involves more wiring but has the advantage of using fuses of smaller capacity and affords better protection

end of the locomotive, through fuse box *d*, through cable *j*, through cable *k* to fuse box *c*, through this fuse box to cable *w* and hence to cable *y* and *z*. Referring back to cable *n*, the current goes through *q*, as mentioned before, part of which goes through fuse box *f*. Cable *q* also connects to cable *r*, and hence to cable *s* to fuse box *e*, to cable *t*, to fuse box *i*, to fuse box *h*, through cable *w* to *y*, and *z*. As seen from the above there are four circuits for the current to pass, with only one set of shoes in contact.

Ribbon fuses are generally used. The fuse box is usually constructed so that the front opens on a hinge to aid in the replacing of a blown fuse. The ribbon fuse is held at either end by wedge-shaped blocks, which clamp the fuse tightly in the jaws. The leads carrying the current enter the jaws at the back of the fuse box.

THE EXTENT OF THE MOVING PICTURE INDUSTRY in the United States may be judged from the fact that about 300,000 kilowatt-hours of electric current are used daily merely for moving picture machines. The investment in the machine industry alone, devoted to moving picture machines, has been estimated at $11,000,000. Probably 5,000 machines are worn out annually, and the total amount of money absorbed by the industry may be estimated at about $500,000,000 a year.—*Machinery.*

PASSENGER CAR WIRING ON THE SANTA FE

By M. F. HAND

Just before the government undertook the operation of the railroads, the Atchison, Topeka & Santa Fe purchased 50 of the Electric Storage Battery Company's 2-kw. axle light devices to replace gas equipment in smoking cars, coaches and chair cars, which are of the old wooden type with 6-wheel wooden trucks and are used mostly in branch line service, many of them running in districts more or less remote where daily or even weekly inspection is practically impossible.

To accomplish this with the least expense consistent with good service, center deck lighting was decided upon, using in the body of some of these cars the Central Electric Company's No. 9900-B ceiling fixture with their Berylite bowls, and the Safety Car Heating & Lighting Company's No. 8800 direct fixture with No. 18648 Soudan shades in others; while the Safety company's No. 9685 pendant fixture with No. 3419 Alba shade is used in hallways of all the cars, and Crouse-Hinds R. F. A.-1 condulets, fitted with their SH-3 porcelain reflectors and RK-527 Norbitt receptacle are used in the vestibules.

In order to avoid expense of new head linings, the lamps in the body of these cars are located in the same panels as were formerly used by the gas lamps, using a 20 in. by 20 in. panel to cover the holes where arms of gas lamps passed through the deck. While this spacing is by no means ideal, by using one 50-watt lamp in each fixture, ample light is provided for reading at any seat in the car. The quantity of light, or foot candles, furnished by the Safety company's fixture, is greater than that given by the Berylite fixture, but the latter provides a better distribution, without glare, shadows or bright spots, and, on the whole, gives much more satisfactory results. If greater intensity is desired or found necessary a 75-watt or 100-watt type C Mazda lamp may be used, and still keep the lamp load within reasonable limit, as the present total lamp load with six 50-watt lamps in body of car and from seven to nine 25-watt lamps in halls, toilets and vestibules is approximately only 16 amperes.

The wires for the lighting circuits are run in 1-in. conduit, which is laid on the roof, using Crouse-Hinds P. J. C. A.-313 condulets for junction boxes, passing the wires through the roof to the fixture through ½-in. nipples.

The spacing and location of the lamps are shown in Fig. 1, where it will be noted that the lights in the car are divided into two circuits: Circuit No. 1, or the "night light" consisting of two 50-watt lamps in body of car and 25-watt lamps in hallways, toilets and vestibules; circuit No. 2 consists only of the remaining four 50-watt lamps in body of the car.

Fig. 2 shows the wiring in detail, circuit No. 1 being served with two No. 10 and circuit No. 2 with two No. 12 wires. The circuits are so arranged that when only the night lights are in use, a 1.0-ohm resistance is in series with the lamps, dimming them to about 24 volts, and when circuit No. 2 is turned on the resistance is cut out, raising the voltage on all lights to normal.

The switch panel is one of the Crouse-Hinds four-cir-

cuit, 3-wire type, so connected that the right and left hand busses carry respectively the positive and negative current to the switches; the center bus being used to control the voltage raising resistance on the regulator panel. While the switch panel is provided with four switches, of the H. & H. push type, only three are used; one for the night light, one for circuit No. 2 and the third for the locker lights; the fourth switch being provided for fan control should they be installed in the cars at a later date.

For the convenience of the trainmen the switch panel is located in the conductor's locker, while the regulator panel is installed in what was formerly the stove room, and is adjacent to the conductor's locker.

The wiring from the regulator panel to the generator, fuses are mounted on the regulator panel and the lighting circuits of course are protected by 12-ampere Edison plug fuses on the switch panel.

The battery used on each car consists of either a 16-cell 11-E. or 13-E. Electric Storage Battery Company's Manchester positive and box negative of 200 or 240 ampere hour capacity, the 200 ampere hour battery being, in most cases, ample capacity, and thus far has proved satisfactory for all runs.

The suspension on these cars is, of course, of the Santa Fe two-point truck type, which affords ample belt clearance over end sill, brake beam and rear loop, using 21-in. axle and 9-in. generator pulleys and 4½-in. belt.

While this is not a strictly "code" job throughout, it

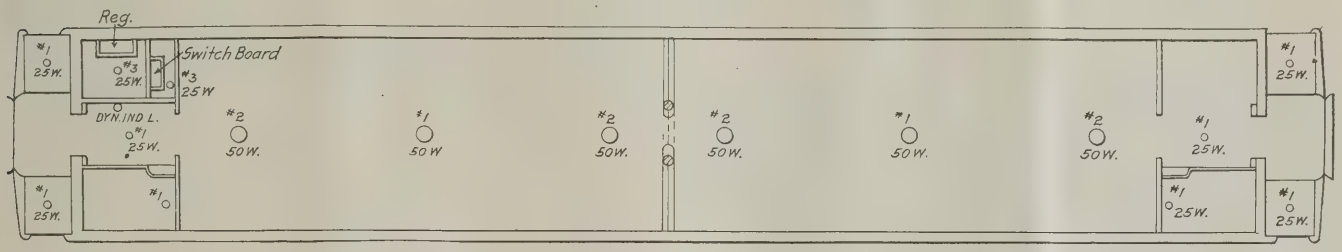


Fig. 1 - Floor Plan.

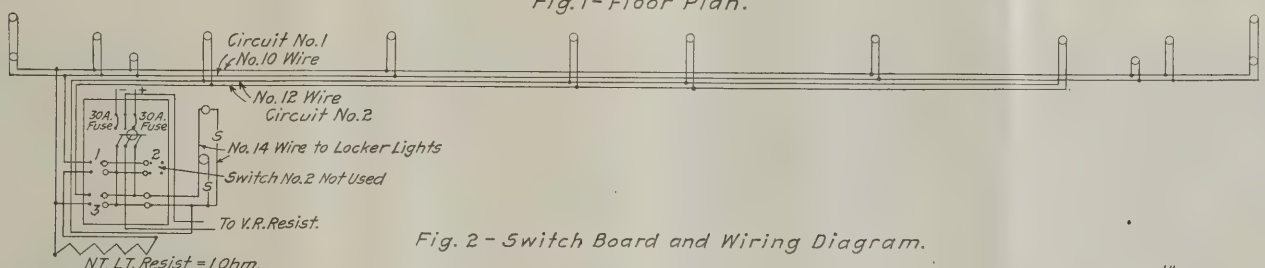

Circuit No. 1 (No. 10 Wire
No. 12 Wire Circuit No. 2
30A. Fuse
No. 14 Wire to Locker Lights
Switch No. 2 Not Used
To V.R. Resist.
NT. L.T. Resist. = 1 Ohm. Underneath Car

Fig. 2 - Switch Board and Wiring Diagram.

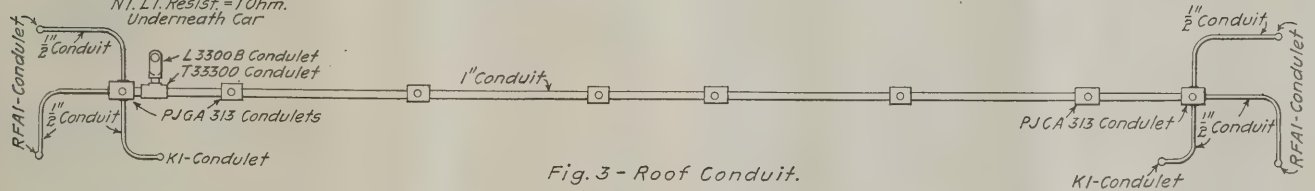


Fig. 3 - Roof Conduit.

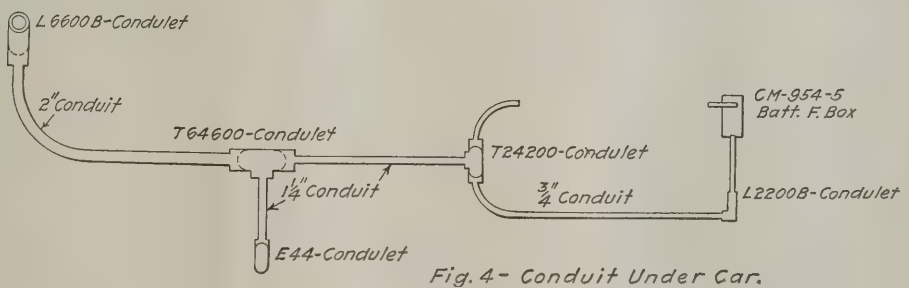


Fig. 4 - Conduit Under Car.

Wiring Diagram and Conduit Plans

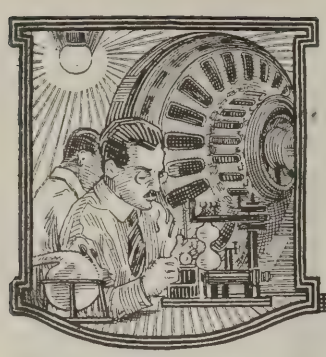
night light resistance and battery, is run in 2-in. conduit from panel to generator, where it is reduced to 1¼ in. and continued to the battery box.

For the battery and armature wires, No. 4 D. B. rubber covered stranded wire is used, and for the field No. 10, solid wire, while No. 12 solid wire is run to the night light resistance, which is located under the car, directly beneath the regulator panel, a galvanized iron casing being used to protect deafening of car from heat, and the resistance from any mechanical injury.

The battery is protected by a 125-ampere, 2,500-N. E. C. fuse enclosed in Santa Fe standard malleable iron fuse box at the end of the battery box; the generator has been approved and considered perfectly safe by the Inspection Department.

Diagrams of conduit on roof and underneath car are shown in Figs. 3 and 4, respectively.

A New Foreman, by the name of Dodgin, was lately put in charge of a gang of men who were working on a building. Upon counting his men he found he was two men short. Looking around he saw two chaps sitting in a corner smoking. Stepping up to them he said: "I'm Dodgin the new foreman." "So are we; sit down and have a smoke," was the reply.

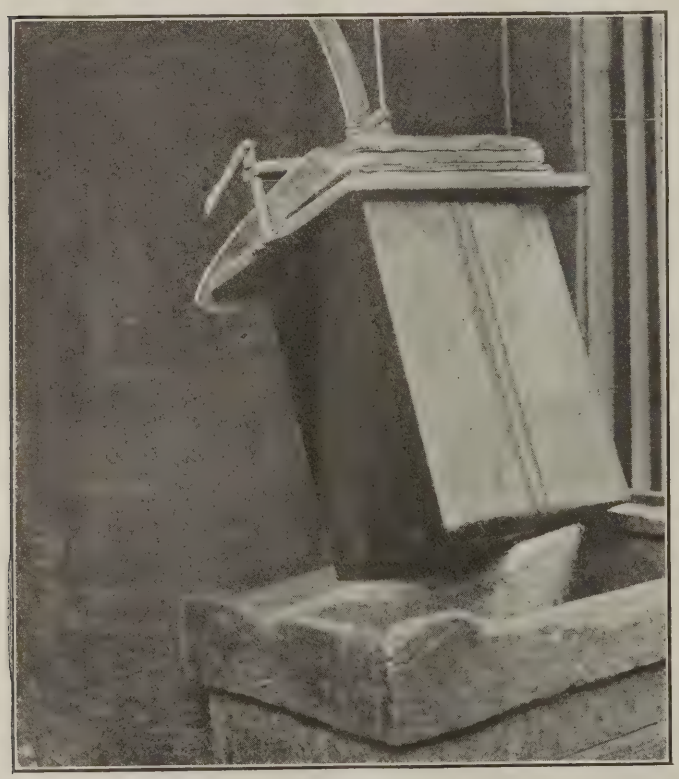


PRACTICAL STUNTS

Equipment for Testing Repaired Storage Cell Tanks

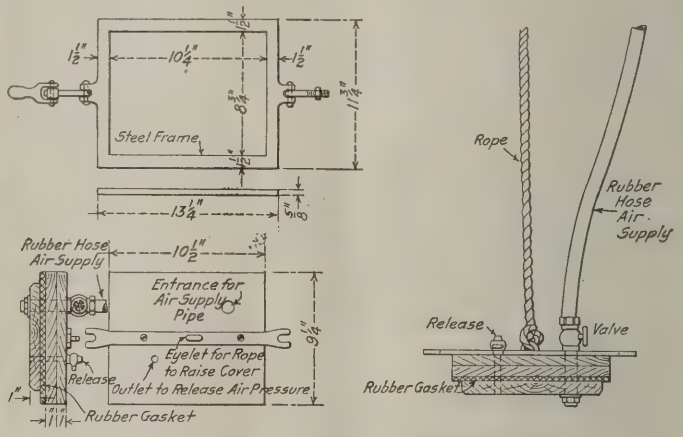
By J. G. Eberler,
Shop Engineer, 47th St. Shop,
Chicago, Rock Island & Pacific, Chicago.

When a storage battery tank has been repaired it is desirable to determine whether the tanks are free from leaks. The Chicago, Rock Island & Pacific has in use at its 47th St. shop, Chicago, equipment for making air tests in a tub of water on repaired storage cell tanks. The photographic reproduction shows such a tank fitted



The Lead Tank Equipped with Cover for Making a Leak Test

with a wooden cover and rubber gasket. Through the top of this cover is an air supply and release pipe. The cover, when placed over the opening of a lead tank, is held in place by means of an iron clamp, which is shown in the detailed sketch. A storage battery tank just fits into the opening of this clamp with its upper rim resting on the surface of the clamp. In making a test the clamp is placed across the sides of an open box, which is deep enough to permit the lead tank to be inserted in the opening of the clamp without the bottom of the tank reaching the bottom of the open box. The wood cover with the gasket is then lowered into place and fastened down by means of bolts. These fit into slots in a metal bar, which is fastened to the top of the cover. As soon as the cover is made air tight the release opening is closed so as to prevent the escape of air when it is turned



The Clamp, Cover and Air Supply Pipe

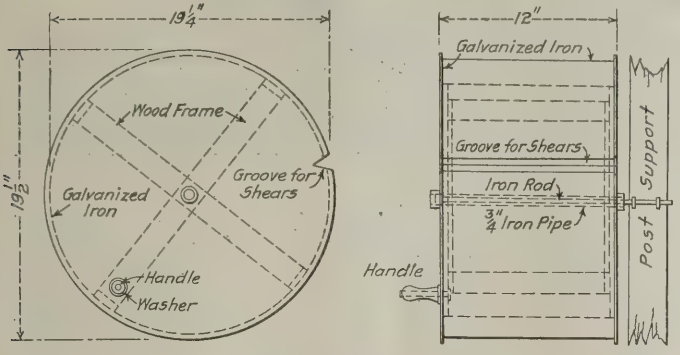
on at the valve just above the cover in the air supply line. The tank is then raised out of the open box and lowered into a tub of water. If any leaks still exist their presence will be noticed by bubbles rising out of the water. The raising and lowering of this device is accomplished by means of a rope, pulley and weight.

A Reel for Measuring Armature Coil Wire

By William Tibbits
Electrical Foreman, 47th St. Shop,
Chicago, Rock Island & Pacific, Chicago.

The illustration shows a device for measuring copper wire for each coil of a Pyle headlight generator armature. This device or reel consists of a wooden frame upon which is mounted a cylindrical galvanized form of the proper diameter so that each turn of wire will give the proper length for each coil of the armature. A portion of the galvanized covering of the reel is bent to form a "V"-shaped groove lengthwise to provide a means for inserting a pair of shears for cutting the wire after a large number of turns have been wound upon the reel. In winding the wire on the reel care must be taken to see that the turns do not lap one over the other; each turn must lay flat on the metal surface of the reel, otherwise such turns that may lap over others would be

longer than required for a single coil. Furthermore care must also be taken in winding the wire on the reel so as not to wind it diagonally across the surface, otherwise each wire when cut will be too long for a single armature coil. After sufficient wire has been wrapped on

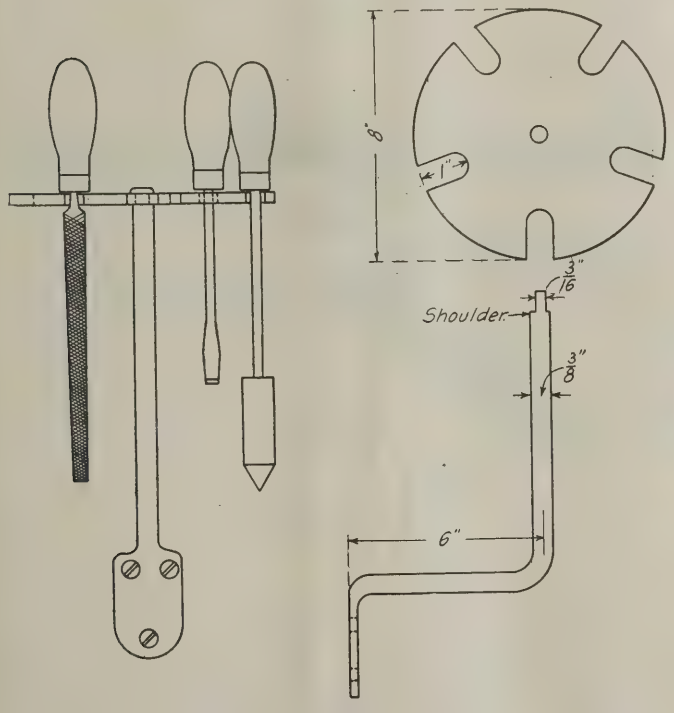


Details of Wire Reel

the reel and each turn cut by means of the shears applied to the "V"-shaped groove, these single wires can be straightened out or looped into bundles and placed away for use in winding armature coils.

A Revolving Tool Holder

In the workroom or shop it is convenient to have the tools most used within reach at all times. A scheme that has been found satisfactory for meeting such a condition is shown in the illustration. It consists of a bracket made of ⅜-in. round iron flattened at one end



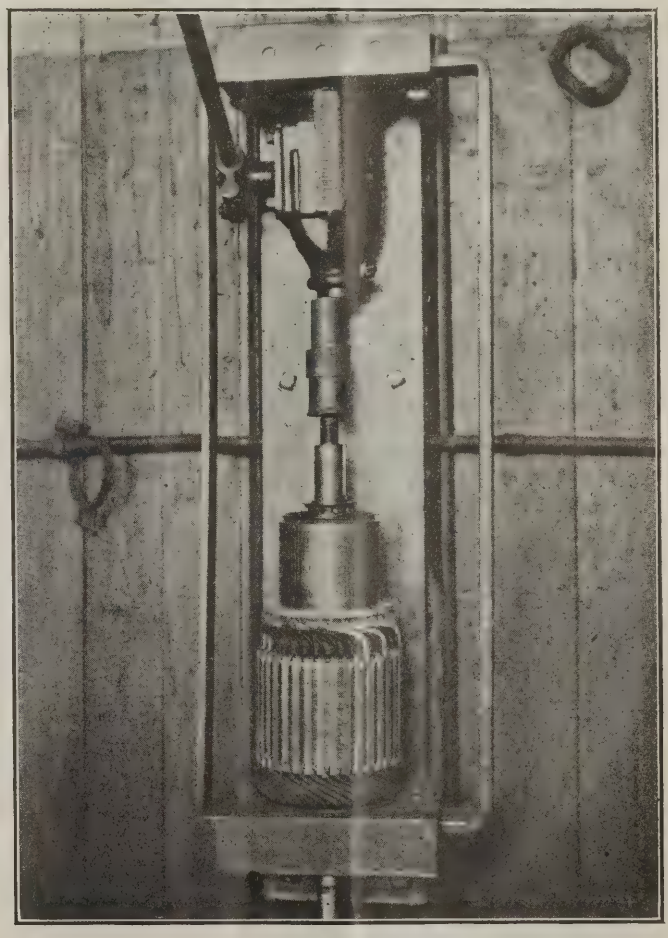
A Bracket for Holding Small Tools

so as to provide a means for mounting it on the end of a bench, wall or post. The upper end of the bracket is provided with a 3/16-in. shoulder for supporting a metal disc 8 in. in diameter which has a series of slots cut into it for holding the tools as shown. The top of the bracket should be riveted down after the disc has been placed on the shoulder. The riveting, however, should be loose enough to permit the disc to revolve, as that is one of the important features of the device.

Hydraulic Press Removes Armature Shafts

By J. G. Eberler, Shop Engineer, 47th St. Shop, Chicago, Rock Island & Pacific, Chicago

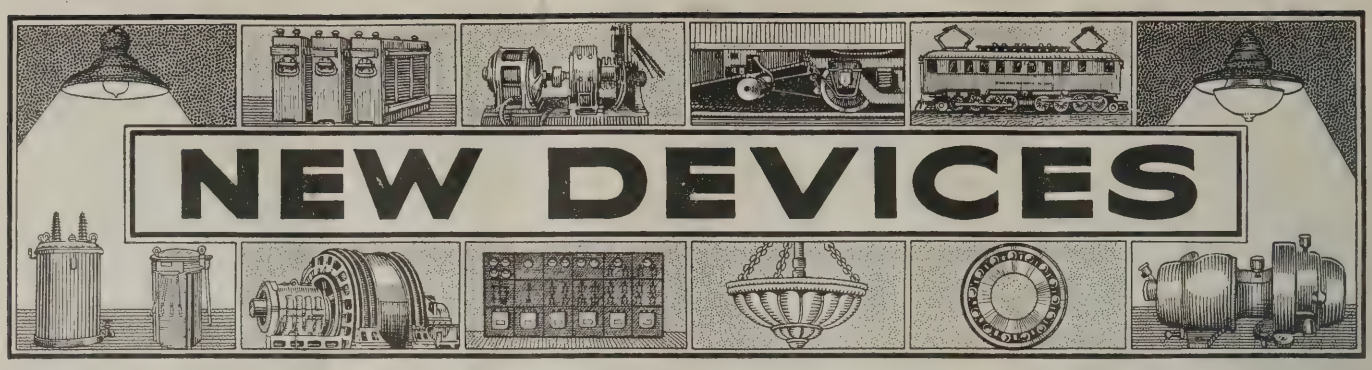
A handy hydraulic press for removing shafts and bearings from armatures was recently installed in the 47th St. shops of the Chicago, Rock Island & Pacific. It consists of a five-ton hydraulic press of a type which is used in baggage car equipment on that road. The press is mounted on a frame of channel and bar iron. The



The Press in Use

top, bottom and back plates consist of 10-in. channel iron. The latter piece is 51 in. long and is bolted to a wooden pillar as shown. The top and bottom plates which are 12 in. long are reinforced by two pieces of ½-in. by 3-in. bar iron, one piece on each side. The lower plate is provided with a 3-in. hole large enough to take armature shafts of various sizes.

This equipment will remove armature shafts from any type of car lighting generators which are provided with such removable parts.



A Quick Way of Opening Storage Batteries

Removing cell plates from batteries has always been a great problem for the charging station, because of the difficulty of getting the plates out without injury to the batteries and of the time consumed for the work.

There is now a new, compact, strongly built device marketed which does away entirely with the time and labor trouble formerly experienced. Plates of a three or six-cell battery can be removed in five and a half minutes. The most stubborn cases yield readily to the new method.

The new apparatus has a steam generator with six jets, three of which are controlled by valves. The valve

The Steam Generator in Use

is closed for 3-cell batteries and is open when all 6 jets are used. The time required to get up sufficient steam is from two to four minutes. The steam generator is fitted with a safety pop valve which blows off pressure at 10 lb. The manufacturers claim, however, that the pressure is never above three pounds.

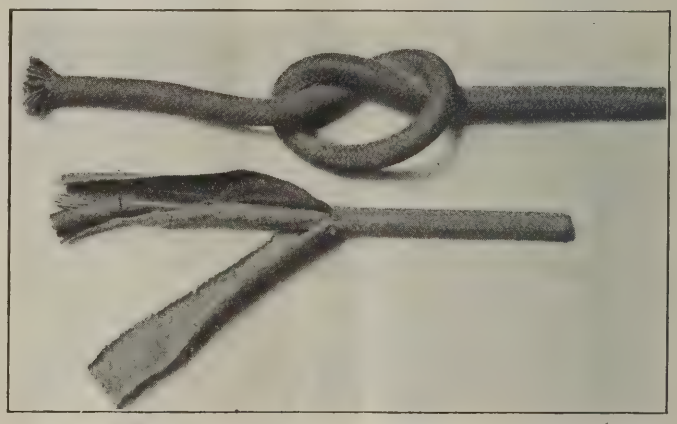
The process of softening the sealing compound is simple. The bent caps of the battery are removed and the jets inserted in each cell. Steam is forced direct into the cell and within four or five minutes the plates are removed. The cost of operation is about three cents. Grease and other impurities can be steamed and cleaned off the batteries also.

The outfit is operated by kerosene, although when desired gas burners can be furnished.

A one-gallon capacity melting kettle for melting the wax for resealing, a 35-lb. capacity lead melting pot for reclaiming lead and a lead mold to make lead sticks are furnished with the outfit, which is manufactured by the Hauck Manufacturing Company of Brooklyn, N. Y.

Hazard Locomotive Headlight Cable

The increased use of electric headlights for locomotives has brought about a greater demand for a wire which would meet the peculiar and exacting conditions which prevail in that service. For that reason the engineering force of the Hazard Manufacturing Company,



Photograph Showing the Flexibility and Construction of the Hazard Headlight Cable

Wilkes-Barre, Pa., was assigned the task of analyzing these conditions and consulting with electrical engineers on several large eastern railroads. The information obtained was used as a basis for the manufacture of a new brand called "Hazard Locomotive Headlight Wire," which has been on the market for a little over a year and which has given satisfactory results.

This grade of wire is furnished in any size, although No. 14, No. 12, No. 10 and No. 8 B. & S. gauge are used principally. During the investigation it was found that a flexible conductor is advisable to permit easy pulling

through conduit and in making short bends and that a flexible conductor withstands vibration without crystallization and ensuing brittleness. It is claimed that a 19 wire strand is most successful. The investigations also showed that a good insulation is necessary, and that it should be tough and elastic, heat resisting so that it will not harden or crack, and of sufficient thickness to meet most severe conditions. Hazard 30 per cent Para insulation is used in the new product. On the outside of the rubber insulation is a special rubber-faced tape which is spirally applied and which it is claimed is impervious to grease, oil, moisture, etc., and hermetically seals the insulation against external influences as well as giving some mechanical protection. The outer covering consists of a tight-fitting, closely-woven cotton braid, which is thoroughly impregnated with a flame-proof compound, which it is claimed will not boil out under high temperature; also that the outer surface will not break or crumble in service. It has been finished smooth to facilitate pulling through conduits and the diameter is as small as practicable. The illustration shows a piece of this wire which has been in service several months over the smoke box of a locomotive, and which was tied in a knot to illustrate its flexible qualities, while close inspection is said to show no mechanical injuries, due to the knot or to the installation and withdrawal in service. The lower portion of the illustration shows a piece of the wire which has been cut to show the various parts such as the stranded conductor rubber insulation, special tape and outer covering, the crack near one end being a cut made to expose the stranded conductor.

Ampere-Hour Meter for Storage Battery Locomotives

A new ampere-hour meter, which has been especially designed to meet the severe requirements of mine locomotive and industrial tractor service, is being marketed by the Sangamo Electric Company, Springfield, Ill.

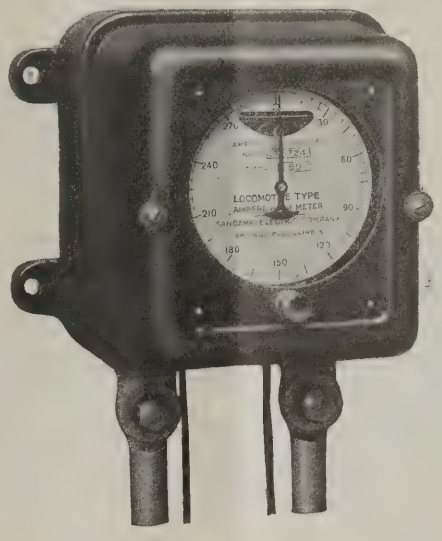
The new meter is capable of carrying a 300 per cent load continuously and a 500 per cent load for a three-minute period, without undue heating of any of its parts.

Special treatment is given to both the armature disks and armature box interior, which has reduced the formation of mercury dross to about one-quarter of that formerly experienced. This has been done to improve the meter operation and eliminate trouble due to meters being slow on account of dross.

A new type of contact at zero is also included in the design. This is mounted entirely back of the dial and operates on cam principle, instead of lever as formerly, thereby reducing the drag on meter and increasing the reliability of the action of the contact.

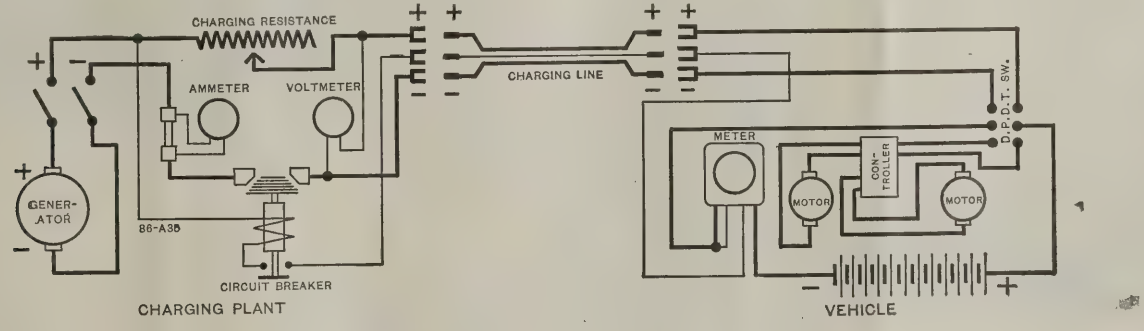
The meter includes a new type of variable resistor element, which is approximately eight times as effective as the resistor element formerly used. This insures reliability of operation and increases the range of adjustment so as to provide a maximum of 50 per cent over charge when desired.

Lock washers throughout and special rigid construction combined with mercury flotation of the rotating elements, make the locomotive type meter practically immune from vibration and load.



The New Ampere Hour Meter

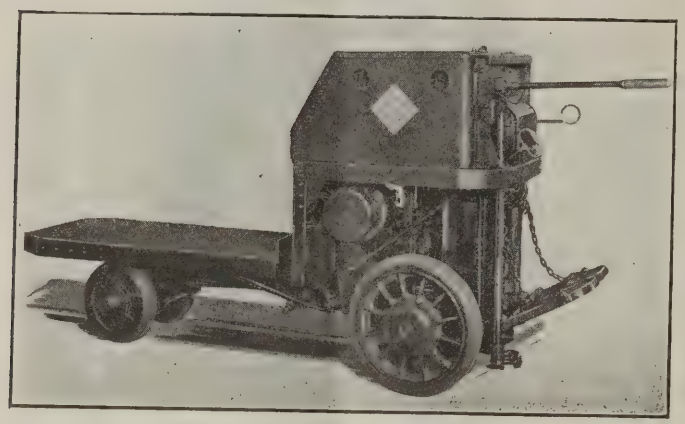
The new ampere-hour meter is intended to be installed permanently in the storage battery circuit on the truck, tractor or locomotive, and registers every ampere-hour which the battery discharges in driving the vehicle. The operator knows at all times how much longer he can run the truck. Since more charge must be given to the battery than has been taken out on the previous discharge, there must be a certain amount of excess charge each time the battery is charged. This feature is automatically provided for in the locomotive type ampere-hour meter by means of the variable resistor device shown in Fig. 3, which causes the meter to run slower by any desired percentage on charge than on discharge for equal current flow. This feature is entirely automatic and once the resistor has been set at the desired percentage of overcharge, no further attention is necessary.



Wiring Diagram of Charging Plant and Locomotive

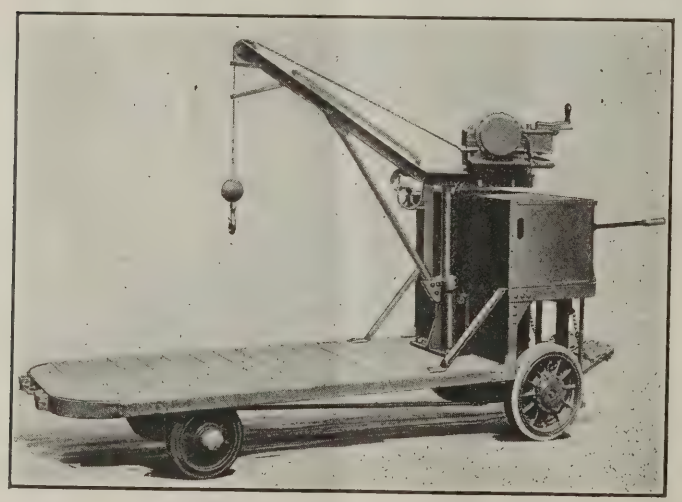
Electric Trucks and Tractors

Four types of electric trucks and tractors have been developed and improved by the Elwell-Parker Electric Company, Cleveland, Ohio, particularly to meet the needs of the railroad field. The type EH truck is equipped with large wheels, high lift elevating platform and interlocked control mechanism. The drive wheels are 21½ in. in diameter with 3½-in. treads, and the trailing wheels are 15 in. in diameter with 3½-in. treads. The vertical motor is direct-connected to a single reduction worm and runs in a dust tight oil case. The brake is located between the motor and differential and is operated by one of the two foot pedals. The driving axle is of the full floating type.



Elevating Platform Truck

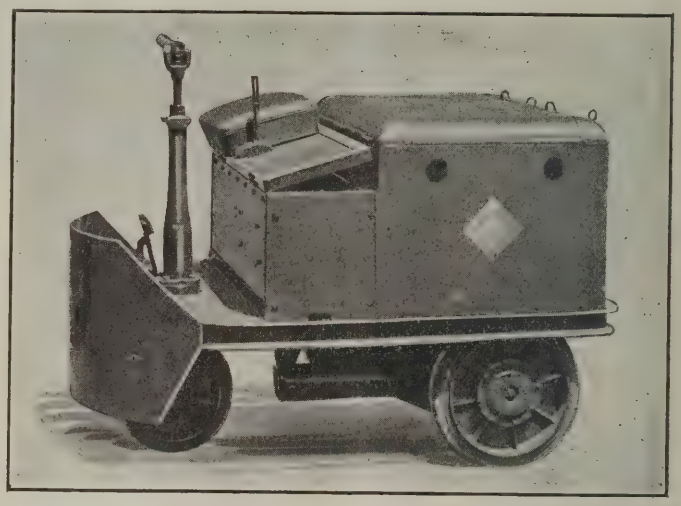
The lifting mechanism is operated by a separate motor especially designed for a service differing from that of the heavier propelling motor. The motor is high off the floor away from the dirt and possibility of damage. This lifting motor may be started or stopped at the will of the operator at any point in the upward or downward travel of the platform, or it may be started and left to automatically stop when the load has reached its highest or lowest position. The upward travel of the platform may be set any lift up to 4½ in., assuring clearance for the separate tray on which the load is carried.



Truck Equipped with Revolving Crane

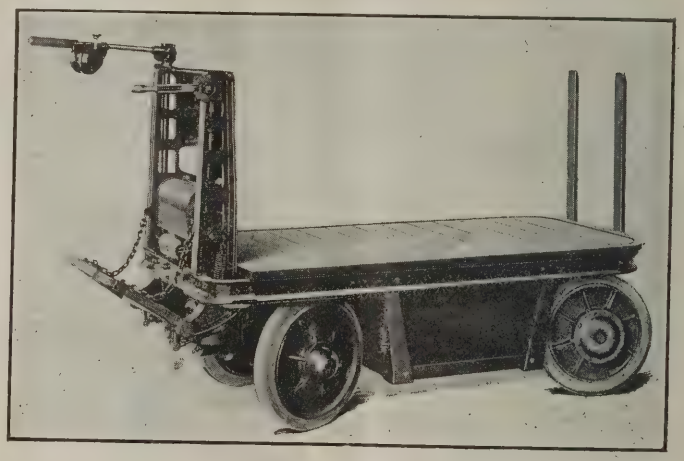
A special device protects the elevating mechanism in case the platform should catch under some immovable object. The platform is three-point supported. It rests on vertical links when up and is steadied by guides on each side. A heavy, hot-riveted steel frame provides support for the equipment and protects it against abuse.

The type CC truck with a revolving crane has been designed for service where heavy castings are stored beyond the reach of a traveling crane. The crane is electrically operated, has a capacity of 1,000 lb. and a reach of 4 ft. It is used to load heavy pieces on the truck and transfer them to machine or forge shops for finishing. The truck has a carrying capacity of 3,500 lb. and operates at a speed of 400 ft. per min.



Three-Wheeled, Light Weight Tractor

The type IK truck with wheels 20 in. in diameter and battery located beneath the platform, so that all of the platform may be used for loading space, is especially designed for operation over poorly planked platforms, rough pavements or soft yards. The motor in this truck is large enough so that it cannot be injured by the battery, even though the motor is at a standstill, with the current full on. This makes fuses unnecessary and assures the climbing of inclines from yards to loading platforms. The capacity of the truck is 4,000 lb., and it operates at a speed of from 400 to 550 ft. per min.



Truck Designed for Operation Over Rough Pavements and Soft Yards

The type TA tractor is a light weight, high torque, short turning tractor for operation where machines or construction restricts operating room. This tractor has

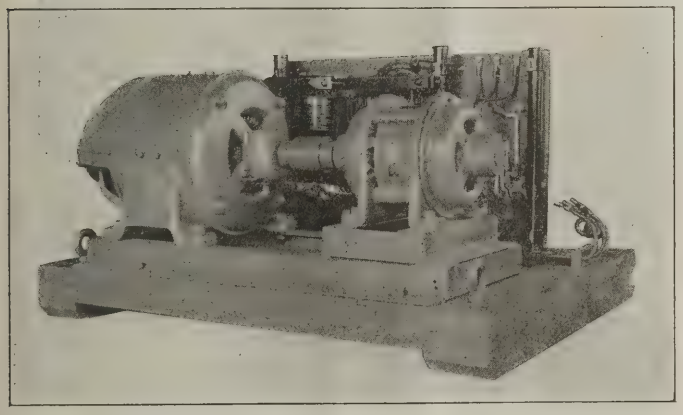
three wheels and carries a battery of 50 per cent greater capacity than a standard truck. It cannot be operated unless the driver is on the seat, which automatically closes the circuit breaker connecting the controller to the battery. There is no fuse in the motor circuit, as the motor will absorb all the current the battery can deliver.

The motor is direct-connected through a single reduction worm on a full floating drive axle. The wheels are 20 in. in diameter with 3½-in. treads, and may be fitted with chains for outside work. The operator sits on a cushioned seat and is protected by a stout dash in front. The tractor has a normal draw-bar pull of six tons and turns practically in its own length.

Welding Sets

The Type Wd-9 Welding Equipment, made by the General Electric Company, includes a constant energy self-excited generator to be driven by belt, electric motor, or engine. When belt driven by engines the speed should be 1,200 r. p. m. or 1,500 r. p. m.

The constant-energy, self-excited generator is designed to embody all the characteristics demanded by arc welding service. There is no external ballast resistance or separate excitation from any external source. Neither a separate circuit nor direct-connected exciter is used. Since the machine provides its own excitation, the voltage characteristics are such that throughout the proper working range of the arc the energy delivered is practically constant. The voltage and current follow the momentary variation in the arc conditions practically instantaneously, and consequently the lag between change in arc conditions and resulting corrective change in electrical conditions is reduced to a minimum. This lag is a possible source of trouble in welding with self-regulating welding equipments when the automatic feature is embodied in the revolving apparatus or mounted on the control panel.

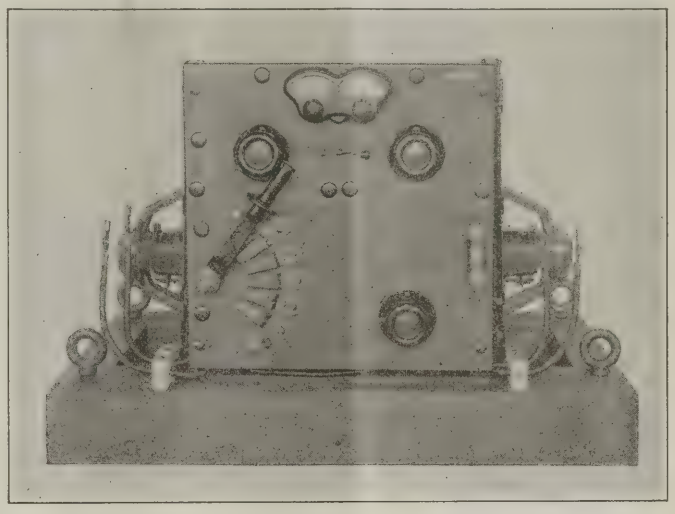


Self Exciting Welding Generator Direct-Connected to an Alternating Current Motor

The generator is so wound as to give a no load or striking voltage of 60 volts which, when the arc is struck, automatically decreases to the voltage required by the arc. This is from 18 volts to 20 volts for the average operator and general work. A long arc is generally considered undesirable. Skilled operators are able to hold a very short arc with a voltage as low as 16 volts, but 20 volts is the average rating of the generator. By adjusting the dial switch on the panel, the current may be varied from a maximum of 200 amperes to a minimum of 75 amperes in 25 ampere steps.

The standard motor generator sets are assembled complete with the panel on a structural steel base so the entire equipment may be picked up by a crane and handled as a unit, or if desired can be mounted on truck.

The connections are simple, the motor leads being brought out at one end and welding leads at the other. Mounted on the control panel are the motor starter and the generator field rheostat, voltmeter, and series field dial switch.



Balancer Type Welding Outfit

Belt driven generators are mounted on standard sliding bases, and the control panel is arranged for separate mounting.

Balancer Set

The constant energy arc welding set of the balancer type is a novel type of arc welding equipment which combines electrical characteristics for the arc with high efficiency and light weight. The characteristics have been determined by a series of practical tests under commercial operating conditions and by oscillograph curves.

This set is built for operation on 110 to 125 volt direct-current supply circuits. The two armatures are mounted on one shaft and connected in series across the 125 volt circuit. One terminal of the welding circuit is taken from the connection between the two armatures and the other from the positive line. By this means each of the machines supplies part of the welding current, and consequently the size and weight of the machines are minimized. The design of the fields and their connections is such that the set delivers the voltage required directly to the arc without the use of resistors.

The welding control panel for the balancer set consists of a slate base 24 inches square, which is mounted on 24-inch pipe supports for portable work and on 64-inch pipe supports for stationary work.

The equipment consists of: a meter and voltmeter inclosed in a common case, dial switch, motor and generator field rheostats, starting equipment, and reactor. The ammeter indicates current in the welding circuit and the voltmeter is so connected, that by means of a double-throw switch, either the line of voltage or the welding voltage can be read.

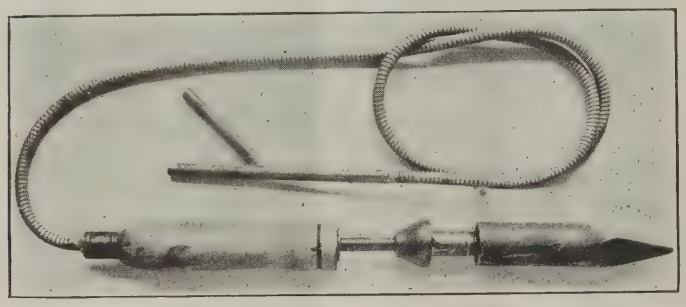
The dial switch is connected to taps in the series field

of the generator, the field being connected to oppose the main field. This feature provides the current control by which six approximately equal steps are obtained between 50 amperes and 150 amperes. If intermediate current values are required, they can be obtained by means of the generator field rheostat. A small reactor is used to steady the arc and current, both on starting and during the period of welding.

Arc welding is always done on metal which is grounded. Since successful operation requires that the positive terminal be connected to the work the supply circuit should be arranged so that it can be safely grounded on the positive side.

A New Soldering Iron

The illustration shows a new soldering iron which is manufactured and sold by the Self-Heated Solder Iron Company of New York. The copper point of this device receives its heat from the combustion of air and gas supplied to the point of burning through a flexible steel-covered tube connected to two pipes, one of which supplies gas and the other air, both being controlled by means of stop cocks located in the air and gas pipes adjacent to the Y connection of the flexible tube. The mixture of gas and air is ignited through three holes, one of which is shown in the illustration near the bell-shaped casting between the handle and the copper point of the device. The burning mixture is projected through the pipe fitting into the hollow portion of the copper point. In order to see the burning flame, for the purpose of regulating its length, a peep hole is provided in the soldering copper.



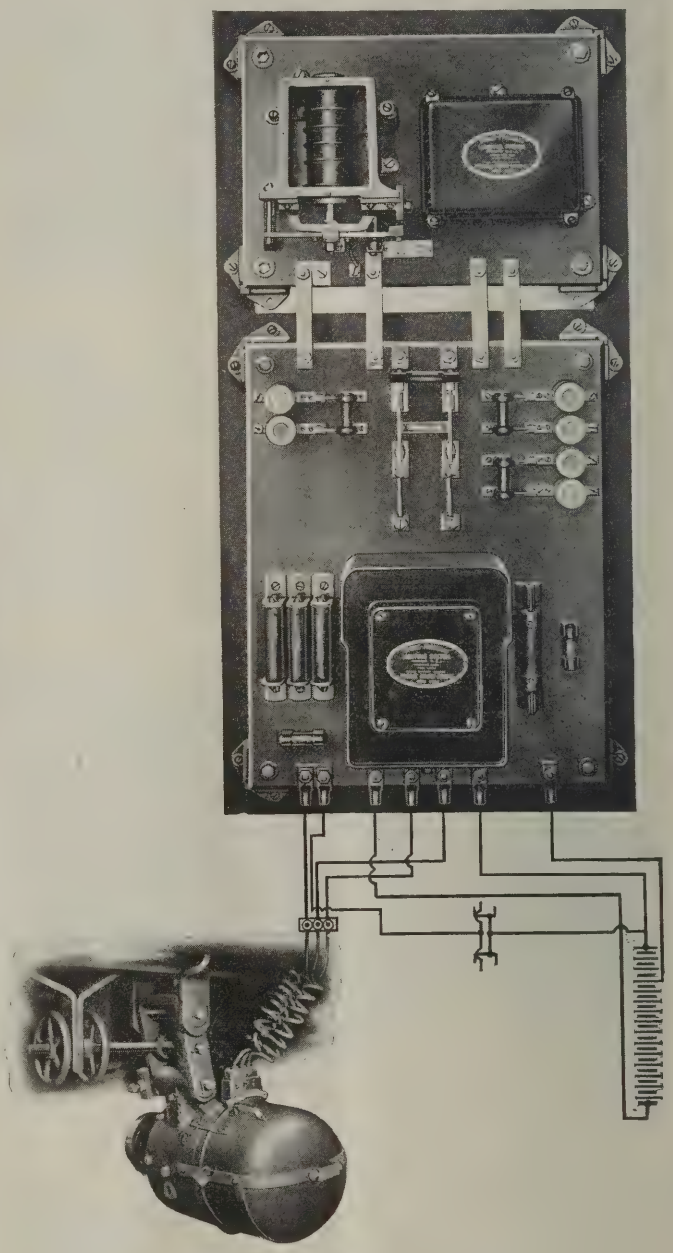
A Gas Heated Soldering Iron

Car Lighting Equipment

The Stone Franklin Company, New York, has introduced a single battery system of car lighting, the operation of which is based on principles never before applied to car lighting equipment. It has been discovered that with constant output from the generator there is a certain relation between voltage and current delivered to the battery when gassing commences. When the charge reaches the gassing point the rate of charge is automatically reduced. In this way excessive gassing is prevented and the amount of flushing required is greatly reduced.

Lamp voltage regulation is obtained in the same manner as with the two-battery system, except that the regulating voltage is obtained from the one battery.

Four devices control the operation of the equipment. These are the constant watt generator output by speed control, the auto triplex switch, the reducer switch and a relay. The sequence of operations is quite simple. When the speed of the train is sufficient to bring the generator voltage up to the proper value the auto triplex switch connects the generator with the battery. Five contact fingers on this switch, without any adjustable springs, interpose properly proportioned lamp resistance for any supply voltage, and finally connect to the positive lighting circuit, a battery potential equal to the lamp voltage potential which is used for lamp voltage regulation.



Panel, Generator and Connections

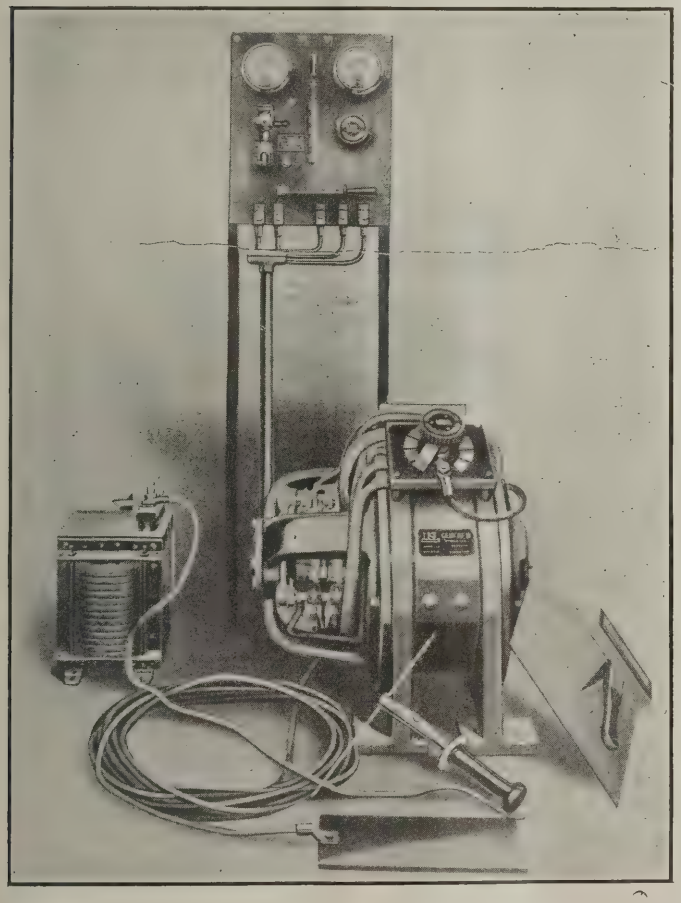
As the battery approaches the gassing point the voltage rises and the current falls off. When gassing commences the relative values of voltage and current are such as to cause the reducer switch to operate. This switch shunts out a part of the generator current through a resistance, thereby reducing the rate of charge of the battery. It also prepares the relay to operate at a predetermined battery voltage. After the reduced charge rate has been

continued for a period of time, the relay disconnects the generator by opening the triplex switch when the battery voltage has increased to a certain predetermined value.

A change of adjustment of the reducer switch makes it possible to use either lead-acid or alkaline batteries with the same equipment. If two batteries are wanted for dining car or private car service they may be taken care of by the addition of a change-over switch.

Portable and Stationery Electric Arc Welders

The U. S. Light and Heat Corporation, Niagara Falls, N. Y., has developed two electric arc welding machines, either of which may be used as portable or stationary equipment. These machines have been designed particularly to meet the requirements of railroad work. For shops where it is practicable to bring the parts to be welded to within 50 or 75 feet of the welding apparatus, the welding machines with their auxiliary equipment are made up for stationary mounting on floors or platforms. The same machine, mounted on a truck, and equipped

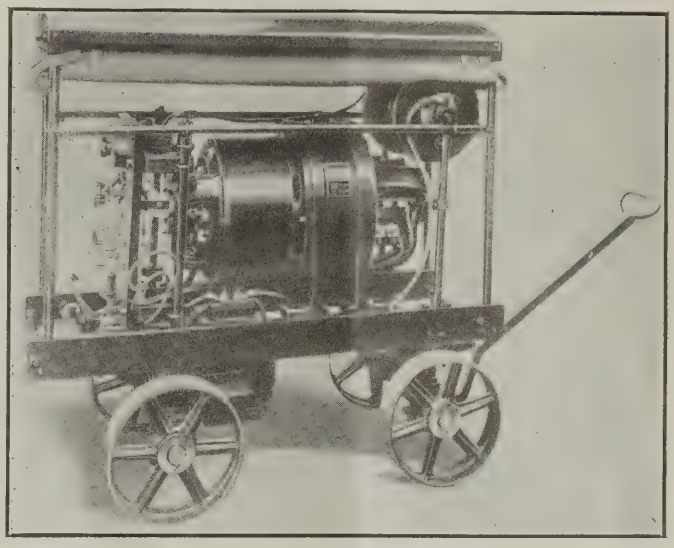


Converter Type Welder for Stationary Mounting

with more compact auxiliary apparatus provides a portable welding outfit which may be taken directly to the work, whether it be in the shop or yard. With a rated capacity of 4 kw. the machines give 200 amperes direct current, or less, with an arc voltage of 17 to 22 volts and an open circuit voltage of from 35 to 65 volts.

For use on 100 to 125 volt d. c. circuit the machine is made in the form of a convertor. The convertor weighs 665 lb., and delivers current at the arc through the stabilizing reactor with an efficiency of 65 to 70 per cent.

On all other kinds of electric supply circuits, the welding machine is made in the form of a motor generator. This machine consists of a 7½ hp. alternating current or direct current motor with a 4 kw. welding generator. The generator is inherently regulated, compound wound, self excited and has a drooping voltage characteristic.



Motor-Generator Type Welder Mounted on Truck for Portable Service

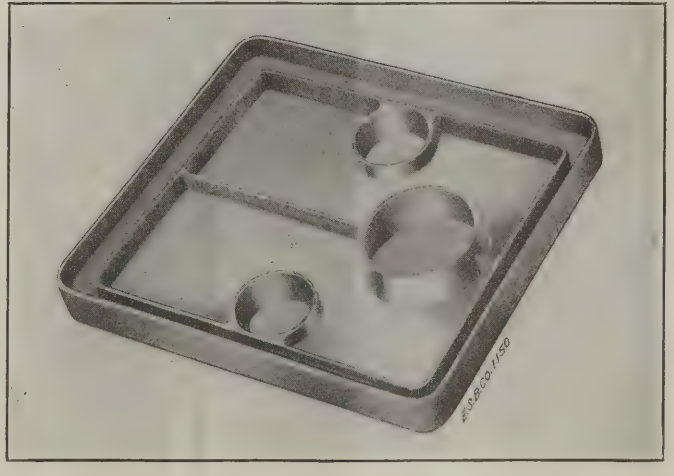
It is claimed that both the generator and the convertor produce an arc particularly suited to arc welding.

For portable use, either machine is mounted on a truck, and equipped with a panel, reactor, cover and cable reel. The truck is 28 in. wide, 55 in. high, over all, 54 in. long and weighs, with complete equipment, about 1500 lb.

New Type of Battery Jar and Generator Suspension

The Electric Storage Battery Company, Philadelphia, Pa., has introduced into the car lighting field a new type of battery jar and cover and a new type of body hung generator suspension.

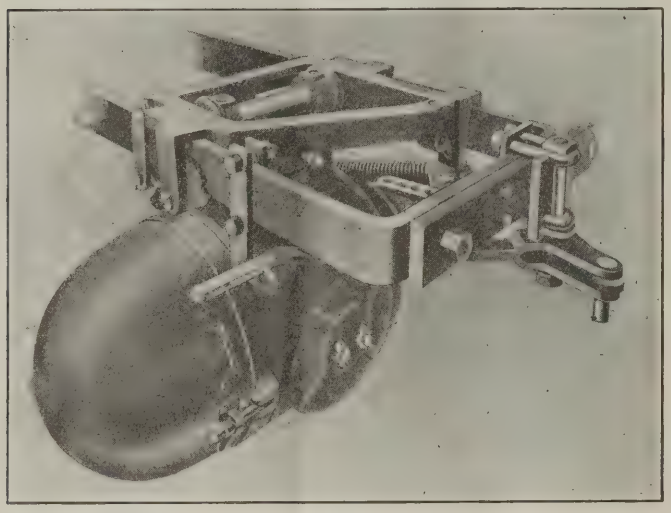
The battery tank consists of a compound rubber jar



Double Flanged Cover for Rubber Jar

with a double flanged alloy cover. It has been designed to eliminate the troubles which have been experienced in the past with the lead lined tanks, due to the develop-

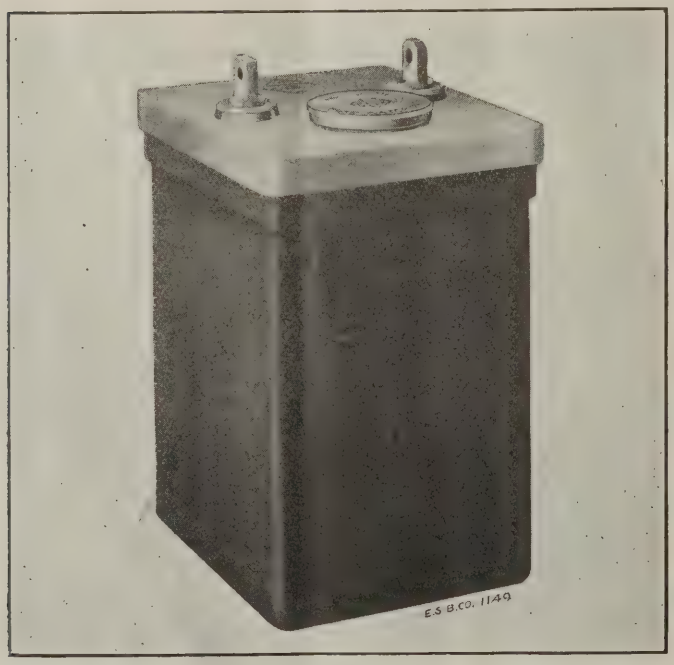
ment of leaks in the lead lining. These leaks are largely caused by electrolytic action of current escaping from a grounded cell, the effect of which is to corrode the lining. The rubber jar is not subject to this corrosive action. These jars are made of "Giant" compound, which was furnished to the United States Government on a large scale during the war. This compound has been used extensively for storage batteries in mining locomotives



Body Hung Suspension, Showing Belt Tension Release Lever and Tension Adjuster

and other conditions probably more severe than those to be met in train lighting service.

The double flanged alloy cover protects both the inside and outside of the upper edge of the jar. This cover is sealed with a newly developed sealing compound, which



Cell Complete in Compound Rubber Jar with Double Flanged Cover

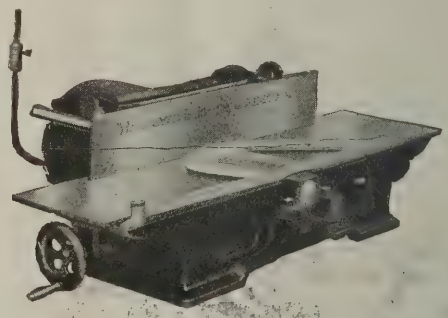
the makers claim permits the cover to be removed and applied again without the application of heat and at the same time forms a perfect seal and will not run at the highest operating temperature encountered. The cells are assembled in two-compartment, solid wood crates and are held in place with paraffin treated wooden shims.

The belt tightening device is the principal part of difference in the new suspension. In the former design of the body-hung suspension, the belt tension was adjusted by means of an adjusting screw. The new device has a lever by which the suspension carriage may be moved forward to the operating position, or may be moved back quickly toward the truck to release the belt when necesary. An adjustment is provided for taking up the stretch of the belt so that the proper belt tension may be maintained without the necessity of cutting the belt. The generator may be mounted right hand or left hand; the generator terminal box, safety chain and spring mounting are reversible, and a right hand or left hand suspension carriage may be had as desired.

A New Bench Type Jointer

A machine known as the 6-inch Wallace Bench Jointer, similar to the 4-inch Wallace Bench Planer, and retaining all of the features of its smaller predecessor is being marketed by J. D. Wallace & Co., Chicago, Ill. This new machine is capable of developing three times the power possible with the smaller machine.

Despite its greater size and power, the machine can



The New Jointer

easily be picked up by one man and carried wherever there is work to be done; and as it is equipped with its own motor, lamp cord and plug all ready for operating at any time from an ordinary lighting circuit, it represents a definite advance in wood working machinery.

In many wood working shops a considerable amount of time is consumed by workmen walking back and forth from their benches carrying small work to the big stationary jointer. From the standpoint of economy the new Wallace product is effective because it enables the workman to do the bulk of the small planing right at his bench, thus saving considerable time and releasing the big jointer for major operations.

An interesting feature is the fence that has been developed in connection with this new machine. This fence is mounted on the motor and slides backward or forward on rods rendering it quickly and accurately adjustable. The fence is also designed so that only a fraction of an inch is lost on the table when the fence is set for beveling.

Ball bearings are used on all motor and cutter head bearings, thus eliminating friction and prolonging the life of the machine.

An ingenious arrangement of the flap and shutter guard has been effected by mounting the shutter guard on the cutter head bearing rather than in grooves.

General News Section

The Memphis (Tenn.) Freight Bureau recently adopted a resolution urging the Railroad Administration to allow the St. Louis Southwestern (Cotton Belt) to re-enter Memphis. Owing to the fact that the St. Louis Iron Mountain & Southern was established by the Railroad Administration as the initial and terminal line between Memphis, Tenn., and Fair Oaks, Ark., the St. Louis Southwestern has not been running into Memphis for several months.

For the Alaskan Railroad the appropriation for the next fiscal year, as fixed by the Senate in the Sundry Civil bill is $12,000,000. The Alaskan Engineering Commission estimates that the railroad will be completed in 1921 at a total cost of $50,436,971, or about $73,200 a mile. It is planned to employ between 5,000 and 6,000 men on the project this summer. In the same bill, the Senate, overruling its committee on appropriations, increased the appropriation for the valuation of railroads from $2,000,000 to $2,500,000, which is the sum approved by the House.

New York to Chicago in Eight Hours, 43 minutes is the latest record of the airplanes carrying mail. This is the time made on July 1, and regular service is promised. The distance is estimated at 750 miles. The airplane started at 5:15 A. M., and flew to Bellefonte, Pa., at 123 miles an hour; another airplane took the mail from there to Cleveland, at 100 miles an hour, and thence the bags were carried by the regular airplane to Chicago, arriving at 12:58 P. M. The second assistant postmaster general says that on letters to the Pacific Coast about 24 hours will be saved; and he expects to take 12,000 such letters each trip.

Honorably Discharged Officers in considerable number, many of them experts or technicians, and many with years of experience, are registered at the main office of the War Department at Washington, D. C., for assistance in securing employment fitted to their capacities. All of the men registered have superintended men in the field under trying conditions, and practically all professions and trades are included among them. Arthur Woods, assistant to the Secretary of War, says that only about 7 per cent of American army officers need this assistance, and of these, two-thirds of the number have usually found positions before the assistance of the War Department is available.

The Ohio Electric and Controller Company, Cleveland, Ohio, announces that it has appointed as its representatives the following firms: The Iron & Steel Equipment Company, Pittsburgh, Pa.; Williams, Beasley Company, Chicago; Linn O. Morrow, Philadelphia, Pa.; J. W. Dopp Company, Detroit, Mich.; Kelly, Powell, Ltd., Winnipeg, Canada; Wonham, Bates & Goode, Inc., Montreal, Canada; Shook & Fletcher Supply Company, Birmingham, Ala.; Wonham, Bates & Goode, Inc., New York City—London, Paris, Havana and Rio De Janeiro; Mitsui & Company, New York—Japan China, Philippine Islands and Honolulu; Gustav Neilson A/S Christiania, Norway, Sweden and Denmark.

The Baldwin Locomotive Works will open a branch in Buenos Ayres in September under the direction of Wallace R. Lee. A Baldwin branch is also scheduled to open in Madrid, Spain, in July and will be in charge of H. P. Austin, a nephew of William L. Austin, until recently chairman of the board of directors of the Baldwin Locomotive Works.

Col. C. H. Crawford, recently discharged from service with the United States Government at the Eddystone munition plant will sail for Rio de Janeiro in August, where he will inaugurate the Brazilian branch for the same company.

Mr. Lee owes his appointment to the Argentina branch to his successful conduct of the West Indies office at Havana, Cuba, which under his direction grew into importance and favor.

Training for Commercial Engineers

A conference of representatives of engineering colleges was held at Washington, D. C., on June 23 and 24 to consider the business and engineering training desirable for engineering students. The outcome of this conference was expressed in resolutions which stated that industrial and commercial development has created a demand for men with technical engineering training and business ability and that industries are seeking men with this preparation. To meet this demand it was urged that economic phases of engineering subjects should be emphasized wherever possible in engineering instruction through teaching values and costs and introducing or extending courses of general economics, cost accounting business organization and business law. It was further urged that the engineering phases of economic subjects should be emphasized wherever possible in commercial instruction and that institutions with departments of engineering and economics or commerce consider some plan of co-ordinating these courses.

Four Electric Locomotives for the Swiss Federal Railways

Following a conservative experimental plan, the operating officials of the Swiss federal railways ordered four different types of electric locomotives, two of which have recently been put in service. Two were ordered from the Ateliere de Construction Oerlikon of Oerlikon, Switzerland, and two from Brown Boveri & Co., Ltd., London, England. Each company was to supply one passenger and one freight locomotive. The mechanical parts of all of the four locomotives were supplied by the Swiss Locomotive & Machine Company, Winterthur,

Switzerland. The Oerlikon locomotives have been delivered and tested on the Loetschberg Railway.

All of the locomotives are designed to operate from overhead trolleys carrying 15,000-volt, single-phase power. A point of particular interest in connection with the design of these locomotives is that the same general method for transmitting power from the motors to the driving wheels is employed in all of the four designs. The motor pinions engage gears on jack shafts, which in turn are connected to the driving wheels by side rods. The side rod arrangement on the Oerlikon locomotives is quite different than that on the Brown Boveri locomotives. The two Oerlikon locomotives are of the 2-6-2 and 2-4-4-2 type, and weigh 91 and 113 tons, respectively. The two Brown Boveri locomotives are of the 2-4-4-2 and 2-6-6-2 type, and weigh 118.5 and 133.5 tons, respectively.

Electrification of Railway in Brazil

Recently a director of the Central of Brazil Railway, Government owned and operated, presented to the Minister of Communications plans for the electrification of the suburban lines of the road and the trunk line from Barra to Pirahy, as well as general plans for the suburban service and the closing of the roadbed from the main station to Deodoro, writes Commercial Attache J. E. Philippi, Rio de Janeiro.

The Commission chose the type of high-tension, continuous current for the suburban service, and recommended that the current be purchased from one of the existing power companies rather than have the company install a plant of its own.

The approximate cost of the rolling stock, substations, aerial lines, etc., is estimated at $4,307,377. This does not include the cost of car sheds at the main station and at Deodoro.

The first work to be undertaken will be fencing in and raising the level of the track in order to avoid accidents. It is believed that by closing in the lines the revenues of the suburban service will be greatly increased, as such a step will facilitate a better fiscalization of the passenger receipts. This work will probably cost about $1,398,238, the estimate being based on the prevailing prices of materials.

The director added that in case the total amount required for this work was not available during the present fiscal year, it would at least be well to begin the work of closing the line, as a half million dollars was appropriated for this purpose in the budget law for this year.

Upon receipt of the plans, the Minister of Communications approved them and directed that the work of closing in the line from the central station to Deodoro be initiated.

To Electrify Belgian Lines

Electrification of Belgian railways has been decreed by the Minister of Railways, following a favorable report on such a project made by a committee appointed to investigate such a course, according to a press dispatch from Brussels on June 20. The first line to be electrified will be that from Brussels to Luxemburg, and later the Brussels-Ostend railway. Action to this end probably will be taken in August, with the expectation of beginning the reconstruction work at the beginning of next year.

PERSONALS

Chester I. Hendricks, electrician first class of the St. Louis-San Francisco railroad at the West Shop, Springfield, Mo., has been transferred to Sherman, Texas, in the same capacity.

Dave E. Herndon returned to his former position on June 1 as division electrician of the Chicago, Rock Island & Gulf, with headquarters at Fort Worth, Texas, after serving in Company B of the 13th Railway Engineers.

Lewis J. Bellew, formerly an axle light maintainer on the St. Louis-San Francisco railroad at Kansas City, Mo., has returned from Army service in France and is now electrician's helper at the West Shop of that company at Springfield, Mo.

William W. Thompson, a former axle light maintainer on the St. Louis-San Francisco railroad at Sapulpa, Okla., returned to this company on July 1, after serving with the American army in France, as electrician first class at Oklahoma City, Okla.

W. Lyall Gray has been appointed resident engineer in Canada for the Stone Franklin Company, with headquarters in the Transportation Building, Montreal. Mr. Gray received his education in English technical schools and has been associated with J. Stone & Company, Limited, for fifteen years, the last ten being spent in Canada.

Charles G. Du Bois, vice-president of the Western Electric Company, was elected president, with headquarters at New York, on July 1, to succeed H. B. Thayer, who has resigned after 38 years of service to assume the presidency of the American Telephone & Telegraph Company. Mr. Thayer was elected chairman of the board. Mr. DuBois was born in 1870, and after his graduation from Dartmouth College in 1891, he joined the Western Electric Company in New York as a clerk in the accounting department. In 1896 he was appointed chief clerk at the New York office, and in 1898 he was elected secretary, with office at Chicago. Shortly after assuming the duties of secretary, Mr. DuBois was also made supervisor of branch houses. In 1907 he was transferred from the Western Electric Company to the American Telephone & Telegraph Company as its controller. In 1917, shortly after the entry of the United States into the war, he went to Washington to serve as controller for the American Red Cross, and after systematizing the Red Cross accounting work and organizing a department to carry it on, he resumed his duties with the company. On October 1, 1918, Mr. DuBois rejoined the Western Electric Company as vice-president, which office he held until his election, on July 1, as president of the same company.

C. G. Du Bois

H. L. GARBUTT, for the last six years manager of the line material section of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed manager of the supply division of the Westinghouse San Francisco office.

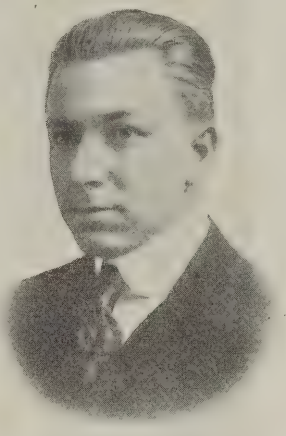
In 1908 Mr. Garbutt became a part of the sales organization of the Drew Electric & Manufacturing Company of Indianapolis, handling various types of overhead line material, with which company he remained until 1909, when he entered the supply department of the Chicago office of the Westinghouse Company, as line material specialist, in which position he served until 1913, when he was made manager of the line material section, with offices at East Pittsburgh, Pa., serving in the capacity of manager until his recent promotion.

HARRISON G. THOMPSON, who on June 1, 1919, resigned from his position as vice-president and general sales manager of the Edison Storage Battery Company, has incorporated the Transportation Engineering Corporation, with offices at 200 Fifth Avenue, New York. The officers are as follows: H. G. THOMPSON, president; F. V. MCGINNESS, vice-president, and HAROLD H. SMITH, secretary - treasurer. The new corporation will act as railway distributors for the Edison Storage Battery Company and for the Automatic Transportation Company, of Buffalo, New York. It will handle the Edison Storage Battery for train lights, railway signalling, multiple unit control, and for other purposes to which storage batteries may be applied. It will also handle the complete line of industrial trucks, tractors, and industrial engines as manufactured by the Automatic Transportation Company, with such apparatus as charging equipment, incident to the above lines.

H. G. Thompson

Mr. Thompson became associated with the Edison Storage Battery Company in 1910, and was elected a vice-president in 1913. He was born at Weston, Mass., in 1875. In 1896 he entered the service of the Pullman Company, and after having been with that company for two years was made foreman of electricians. In 1900 he resigned to become foreman of the battery department of the Riker Motor Vehicle Company, but left the latter at the time of its absorption by the General Vehicle Company, of Hartford, Conn., to become associated with W. L. Bliss, one of the pioneers in electric car lighting development. In 1905 he entered the service of the Pennsylvania Railroad and was placed in charge of electric car lighting, with headquarters at Jersey City, N. J. About one year later he became electrical superintendent of the Safety Car Heating & Lighting Company, New York, and was in charge of that company's electrical laboratories during the development of its first electric car lighting system. In December, 1909, he was appointed manager of the railroad department of the Westinghouse Storage Battery Company and later for a short time, was in the employ of the United States Light & Heating Company, New York. In July, 1910, he became manager of the railway department of the Edison Storage Battery Company; in July, 1915, he was appointed general sales manager, and became also vice-president of the company in July, 1918.

FRANCIS V. MCGINNESS, who recently resigned as railway sales manager of the Edison Storage Battery Company, is vice-president of the new corporation. He graduated from Columbia University, School of Engineering, with the degree of electrical engineer in 1910, and then spent a short time in the engineering departments of the New York Telephone Company and the New York & Queens Light & Power Company. He became connected with the Edison forces in 1911, being then engaged in experimental work in Mr. Edison's laboratory. At this time he also received a thorough training in the manufacture of the Edison battery. He was later appointed assistant manager of the railway department of the Edison Storage Battery Company, and in March, 1916, he was promoted to manager of the same department.



F. V. McGinness

HAROLD H. SMITH, electrical engineer of the Edison Storage Battery Company, becomes secretary-treasurer of the newly formed Transportation Engineering Corporation. Mr. Smith graduated from the Polytechnic Institute, Brooklyn, N. Y., in 1909, with the degree of E.E. For one year thereafter he was employed by the Pennsylvania Tunnel & Terminal Railroad, in the office of the chief engineer of electric traction, in connection with the New York electrification of the Pennsylvania Railroad. He then joined the staff of the laboratory of Thomas A. Edison, at Orange, and for several years was engaged in research work in connection with the Edison Storage battery. Later he became connected with the selling department of the Edison Storage Battery Company in the capacity of engineer and retained that position up to the time of his recent resignation.

H. H. Smith

Bertram Smith, assistant general sales manager of the Edison Storage Battery Company, Orange, N. J., has resigned to become president and general manager of the Automatic Electrical Devices Company, Cincinnati, Ohio, effective July 15. Mr. Smith has had more than 20 years' experience in the storage battery industry. He formerly served as secretary and treasurer of the old National Battery Company, which sold the Sperry plate, and after the absorption of this company by the United States Light & Heating Company, he was for a number of years manager of the western territory, with headquarters at Chicago. In 1913, he resigned to become assistant manager of the Edison Storage Battery Supply Company, with headquarters at San Francisco, and in 1915, was appointed manager of the Detroit sales district for the Edison Storage Battery Company, Orange, N. J. In September, 1918, Mr. Smith was made assistant general sales manager of that company, with headquarters at Orange.

Major Charles E. Sholes has been elected vice-president, director and general sales manager of the Edison Storage Battery Company to succeed Harrison G. Thompson, who has resigned to organize and conduct the Tranportation Engineering Corporation of New York. Major Sholes has heretofore been identified with the construction, operation and management of chemical industries. He was the active member of the Creditors' Committee of the Aetna Explosives, Inc., during the receivership. During the war he served as major in ordnance, first as chief of the chemical branch, which attended to procurements of chemical platinum, cotton linters, alcohol, acids, etc., and as army representative before the War Industries Board, and numerous other committees and boards. He was subsequently made contracting officer for the United States on the staff of Col. Lamont, and retains his rank in the Officers' Reserve Corps. He is also chairman of the Society of Chemical Industry.

Major C. E. Sholes

TRADE PUBLICATIONS

Harvey Hubbell, Inc., Bridgeport, Conn., is distributing two envelope folders illustrating and describing several of the latest developments in multiple plugs and current taps.

The National X-Ray Reflector Company, Chicago, in its latest issue of "Eye Comfort" presents a number of photographs showing the possibilities of both indirect and flood lighting apparatus.

The Esterline Graphic, monthly publication of the Esterline Company, Indianapolis, Ind., gives an interesting account of the Esterline graphic recording apparatus as it is used in the offices of executives.

Trumbull Cheer for June presents an unusual attractive appearance. The poem on the inside front cover entitled "At The Peace Table," has much merit and is decidedly apropos. "An Illustrated Lesson In Electricity" on page 11 is one of the choice bits of humor which characterize this publication.

American Car & Foundry Company, New York, distributed a 12-page booklet at the Atlantic City conventions last month in which were described the company's war time activities. Through the protographs contained in the pamphlet a very clear idea may be had of the magnitude of the United States artillery program in operation at the time the armistice was signed.

National Metal Molding Company, Pittsburgh, Pa., is distributing a large folder entitled "National Products," in which are illustrated various molding parts and fittings. The fittings shown include snap switches, pull chain receptacles, push switches, angles, tees and crosses, etc., all of which are designed for use with the 2, 3 or 4-wire molding manufactured by the company.

"The Dragon" for June, the house organ of the Fafnir Bearing Company, presents an interesting article on the Liberty motor and illustrates how very important is the use of ball bearings in the construction of this celebrated power unit. In the latter part of the pamphlet some very complete directions and plans are given to re-equip a standard plain bushing loose pulley with ball bearings.

U. S. Light & Heat Corporation, Niagara Falls, N. Y., has recently issued its bulletin 700, devoted to the description of the U. S. L. arc welder which has been lately placed on the market. All of the apparatus used in connection with the arc welding process is well illustrated. Two of the pages are devoted to the tabulation of the various sizes and kinds of welding equipment manufactured by the company.

Benjamin Electric Manufacturing Company, New York, has recently issued a new illustrated catalogue in which is listed the marine lighting and signaling apparatus which it manufactures. The catalogue is divided into five sections, alphabetically designated as follows: Section A, marine fittings; Section B, marine lighting fixtures; Section C, parts for Benjamin marine devices; Section D, signaling apparatus, and Section E, lighting apparatus. The equipment is well illustrated with photographs, and line drawings are used where required to show the construction of parts.

The Page Steel & Wire Company, New York, recently issued a small booklet of 60 pages on welding rods and wires. The booklet contains a large amount of useful information on welding and welding materials. It describes the method of manufacturing armco iron rods and wires for oxy-acetylene and electric welding, illustrated with micro-photographs showing the structure of the material used. It also contains a large number of other illustrations and data in tabular form, including a table showing the diameter of rods to be used on various thicknesses of the metals to be welded, temperature and metric conversion tables and data regarding the properties of elements and metal compositions.

Railway Electrical Engineer

Volume 10 August, 1919 Number 8

WAGES AND PRICES

Nine months have passed since the armistice was signed—nine months of the much heralded readjustment period and yet today there are apparently more difficulties to be adjusted than there were when the terrible world conflict was brought to a close. Unrest, turmoil and strikes abound in every part of the nation. The cost of living has gone higher and higher. The phenomenal wages secured by labor organizations have in reality netted the individual workingman nothing. In spite of the increased number of dollars he receives he finds himself worse off than he was before the war.

Strange as it may seem labor is in certain measure responsible for the predicament in which it finds itself today. Through the operation of simple yet inexorable economic laws the workingmen of the country have succeeded in embroiling themselves in the very conditions which they sought to escape. The aims of labor organizations have been to secure shorter hours and increased wages. So successfully have these aims been attained that there are many industries in the country in which wages have been doubled and in some cases trebled. And what has been the result? The workingman finds himself obliged to pay for every commodity of life tremendously high prices caused by the demands of other workmen in other industries for higher wages. This state of affairs might be carried on indefinitely without benefiting labor in the least. To make matters worse the conditions thus brought about are extremely favorable to the extortionate methods practiced by wily profiteers who have no scruples in charging more for the goods they handle on the way from the producer to the consumer. There are other causes also that help to inflate prices, but there is no one cause comparable in effect to that of the high wage scale throughout the country.

What the workingman needs is not more money. He has today more money than ever before and there was never a time when he could get less for it. The motive lying back of all organized labor in demanding increased wages is the desire to obtain better living conditions, to provide itself with more comforts and luxuries. Labor has succeeded in gaining the money, but has failed utterly in obtaining its object. A man who earns fifty dollars a month and can obtain for himself and his family all that they require for forty dollars has at least no reason to worry, but when the same man has had his wages increased to two hundred and fifty dollars a month and his living expenses boosted to three hundred dollars, he finds himself facing a situation that cannot long endure.

That the real state of things is beginning to be appreciated recently became evident when both the Brotherhood of Locomotive Engineers and the Brotherhood of Railway Trainmen took up the matter with the United States Government. It is highly significant that the latest requests of these organizations have not been for increased wages. Apparently the fact has been recognized that high wages alone will not solve the problem as the present labor movement indicates by its attack upon the high cost of living. The concentrated efforts of these organizations will undoubtedly be reflected in some slight lowering of prices, but the situation is far too complicated to secure quickly any appreciable relief.

The present economic condition is the result of a more or less gradual development in which three factors have been the chief contributing causes. These are, first, the tremendous inflation of the world currency during the war; second, the false valuation placed upon wheat, and, third, high wages. The first of these causes is too gigantic a problem to solve by any simple method, time alone can restore currency to a sound basis. The second can be and probably will be quickly removed by the government when the administration finally awakes to the seriousness of the situation, and allows wheat to be marketed at a natural price. The removal of the third cause depends largely upon universal recognition of the law of supply and demand. High wages and low prices abound in incongruities. There is but one way whereby the two can exist simultaneously and that is by the unstinted stimulation of production. Increased production of goods will force prices downward as nothing else can and until this fact is recognized, accepted and put into practice, high wages with low prices can never be accomplished.

GET YOUR TROUBLES BEFORE THEY GET YOU

Where can one find a man today without troubles? Apparently most of us have them; at least, we think we have. A man without trouble in the railway electrical field is as hard to find as the proverbial needle. But even at that, the electrical man who has a thorough knowledge of his business and is familiar with the different frequencies, phases, currents, eddies, pressures, etc., with which he has to deal is vastly better equipped than another man who does not have this knowledge. There is a saying "A dead fish floats with the stream; but it takes a live one to swim against it." Unfortunately, however, many men engaged in railway electrical work are like the dead fishes floating with the stream, they seem to care nothing about the troubles that are liable to happen and which do happen every day. The only object

they have in view is to endeavor to correct the trouble after it shows up. The live fishes, however, have another object in view; they are the fellows who swim against the stream of trouble, seeking out the source before the turbulent current develops into a whirlpool which swallows up everything with reach and carries it down to destruction.

This is not a fish story; it is a serious matter—this question of getting your troubles before they get you. Service is the one thing that the railroads and public demand. Service does not consist of failures, but on the contrary, of successful operation. To prevent failures a thorough system of inspection is required before new or repaired facilities are put into use and a continued, periodical, adequate system of inspection after such facilities are in service. It is realized, of course, that all failures cannot be eliminated because no system of inspection or other means adopted for finding the defects before troubles develop, no matter how good, is perfect, and some of the defects may be overlooked, which sooner or later cause the unforeseen failure to occur. It is a fact, however, that a large majority of failures can be prevented by the institution of proper inspection of the apparatus before and after it is put into service.

ANOTHER REASON FOR ELECTRIFICATION

At present there is apparently much greater activity in the matter of railroad electrification in both Europe and South America than there is in the United States. The chief contributing factor in the promotion of most of these projects is undoubtedly the shortage of coal, which at the present time is selling in these countries at twenty to forty-six dollars a ton. Such prices as these are far in excess of any existing in the United States today, but the indications are not lacking to show that a very appreciable increase in the cost of coal may occur in this country if the attractive prices abroad result in building up an extensive coal export business.

Agents from the United States are now investigating conditions in many foreign ports, relative to prices, port facilities and facilities for transporting coal inland. That the American coal operators are alive to the possibilities of this market is clearly shown by the following extract from a letter to a foreign consumer.

"Gentlemen: We are owners, miners and shippers of the very best grade of coal mined in the United States of America. Our production consists of the famous 'New River,' 'Pocahontas,' 'Tug-River-Pocahontas,' and the high volatile, low sulphur gas coals known all over the world as the standard grade of quality. In addition to our own guarantee, all shipments pass the United States Government inspection at the loading piers."

Should the American producers succeed in building up a large export business coal prices in this country are certain to go higher.

Heretofore, the principal reasons for the adoption of electric operation in the United States have been terminal and trunk line congestion. It was considered cheaper to electrify than to lay additional tracks and to expand existing terminals. With the advent of higher prices for coal, however, another factor is introduced into the electrification problem which will demand recognition. Just what point the cost of coal may reach in this country will depend largely upon the extent of the export business, and at present is purely a matter of conjecture. It is an absolute certainty, however, that if the price of coal approaches anything like the figures quoted in foreign countries electrification projects will command vastly more consideration.

FATIGUE OF ELECTRIC WELDS

Although wonderful progress has been made in the past few years in the development of electric arc welding there are certain phases of the art which have remained more or less obscure. Phenomenal success has been obtained in making welds of high tensile and torsional strength and many tests made upon specimen welds have shown remarkable results. There is, however, another factor which should not be lost sight of in a comprehensive study of electric arc welding and that is to what extent repeated applications of stress affect the ultimate strength of the weld. It is a well-known fact that successive applications and removals of stresses upon materials result in a very appreciable lowering of their ultimate breaking stress. The importance of this factor in connection with welded joints can scarcely be overestimated, particularly in work, upon which depends the safety of human life or the preservation of valuable property.

Recognizing the fact that the laws governing the fatigue of materials applied alike to both solid and welded specimens of iron and steel, the Research Sub-Committee of the Welding Committee of the Emergency Fleet Corporation developed a machine for the purpose of making repeated reverse stress tests of specimens cut from samples of electrically welded joints in ship plates. This particular machine was designed for specimens containing welds made in one-half inch steel plates, but obviously a similar machine could be constructed to handle test pieces of any ordinary diameter. In testing these welded specimens a maximum fibre stress of 25,000 lb. per square inch was adopted principally because this value, while within the elastic limit of the material, is as high a value for ship plate steel as it was thought advisable to go. The specimens undergoing test were so placed in the machine that they received both compression and tensile stress with each revolution of the test piece. Since a satisfactory conclusion could be reached only by comparison, other specimens of the same metal but not containing the weld were subjected to the same tests. The general order of the results obtained at a maximum fibre stress of 25,000 lb. per square inch is about 500,000 revolutions for specimens with welded joints and about 10,000,000 revolutions for solid specimens, before failure occurred. These results would seem to indicate that the arc welded joint lacks the property of withstanding repeated applications of stress far more than does a similar piece of solid material of the same dimensions. If these results can be considered as a criterion, there is evidently room for improvement in the art of electric arc welding. It is just possible that we have been a little too optimistic in considering the results which arc welding has produced, and it might be well in the future to place less emphasis upon the strength of the newly-made weld, and to concern ourselves a little more with its durability under operating conditions.

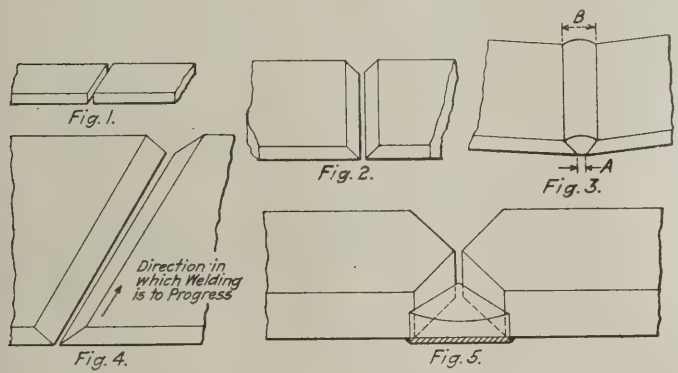
Preparing Work for Electric Arc Welding*

Many Important Factors Require Careful Attention Before Good Work Can Be Accomplished.

By E. Wanamaker and H. R. Pennington

IN detail, the preparation of work to be welded varies with the characteristics of the metal, the thickness of the parts to be welded and, most of all the form and position of these parts. However, general rules serve to indicate the methods to be applied in each particular case. When the material to be welded is prepared properly the job is half done, because the execution of the actual welding process depends in a large measure on the accessibility provided for the operator, such as the arrangement and preparation of the parts to be joined. The methods used for welds of various kinds are brought out in this article. But in order to call attention, relative to the preparation of the parts, the following information may be of value in a general way:

(1) Expansion and contraction should be provided for when it is possible to do so, otherwise the effective strength may be materially reduced or the work left in a distorted or warped condition.



Figs. 1 to 5—Parts to be Joined to Show Effect of Expansion and Contraction

(2) Accessibility should be provided for in order that that the execution of the welding process is simplified for the operator. The work or the position of the parts to be welded should be arranged so as to be the least difficult for the operator to get at whenever this is possible. Good welding can be done in an overhead position, but other positions require less effort and the probabilities for a good weld are greater.

Proper beveling and spacing of parts, to insure uniform fusion throughout the thickness of the parts to be joined, will also determine to a large degree the ultimate strength of the weld.

(3) It is necessary to know what the service requirements of the parts will be in order to make a study of the stresses and strains to which the work will be subjected, so as to determine the kind of weld that should be made. Different kinds of welds will be required. The kind to be used will depend upon whether the strain is great, small, direct tension, bending torsion, prying, compressive, or a combination.

(4) The cleaning of the surfaces, on which fusion takes place, must never be lost sight of. According to the surface of the metal, this mechanical cleaning may be done with hammer and chisel, wire brush, roughing tool, sand blast, emery wheel, file or a combination thereof. The use of chemical agents to slag the oxides from the surface of the work during the realization of the weld, is not to be strongly recommended for arc welding. Mechanical methods of cleaning are preferable.

Expansion and Contraction Require Precautionary Measures

Attention has been drawn to the importance of expansion and contraction in the case of autogenous welding. However, as the preparation and arrangements of parts to be welded are governed largely by this phenomena, it is necessary to refer further to this subject.

It must be understood that expansion and contraction cannot be overcome by force, and it is useless to try to oppose them. We may only hope to avoid or limit their consequences. Also, it must be remembered that a given volume of metal occupies more space when in a heated or molten state than when in a cool normal condition. For example: Two bars, such as shown in Fig. 1, are to be joined by the addition of molten metal between them. No bad effects of expansion and contraction are to be feared in this case because the opening is uniform and the parts are free to expand or contract. However, if two plates such as shown in Fig. 2 with beveled edges are to be joined the situation is different. To begin with the plates are horizontal; but when the weld is completed their relative positions will have changed as shown (exaggerated) in Fig. 3 provided they are free to move. This is due to the difference in the openings at points *A* and *B*; that is, the amount of hot expanded metal added between points *A* (to contract on cooling) is small compared to that between points at *B*; consequently contraction is greater at point *B*. No bad effects of expansion need be feared, since on heating to fusion the beveled edges expand and the parts to be welded approach each other. Also, the tendency for expansion is reduced to almost nothing in the case of metallic arc welding, due to extreme localization of the arc's heat. Distortion may be allowed for, by adjustment of parts before the welding begins, so that when contraction occurs the united plates will form a flat surface.

In welding long butt seams of medium thickness, in addition to the tendency for distortion above mentioned, the contraction of the weld will cause the edges to approach each other as the welding progresses. When it is possible to do so this condition should be allowed for by separating the edges of the plates more at the end toward which the welding is to progress than where the welding is to start, as shown in Fig. 4. The amount of allowance for this contraction varies slightly with the speed at which the work is done and the mass and shape of the parts. *It will usually vary from one to two per*

*This is the sixth article on Electric Welding by E. Wanamaker, electrical engineer of the Rock Island Lines, and H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. Copyrighted, 1919, by the *Railway Electrical Engineer*.

cent of the length of the weld. These figures are approximate. The operator will find the exact spacing required, depending upon conditions, after he has had some experience with welding of this character. He can correct a slight mistake in spacing by varying the speed of his work; that is, if it tends to close too quickly the work should be hurried, and if it does not close quickly enough the work should be prolonged.

Closing of the edges and warping in some cases, may be prevented by clamping or tack welding to compel a slight giving of the metal on cooling and contracting. This, however, is not the best practice, especially with lighter material where the parts being welded become very hot; but it is practiced to a great extent on heavy work, *and if the metal in the weld is ductile the contraction will not produce breaks or even serious strains.* An example of this is illustrated in Fig. 5 in the welding of locomotive frames, where it is very seldom that any allowances are made for contraction, yet many such frames have been welded successfully.

Even though the members of heavy parts are free to move, there should be very little distortion in the case of metallic arc welding as contraction will have occurred where the welding was started long before the weld could be completed. Pre-heating may be employed in certain cases, but it is not used to as great an extent with metallic arc welding, as it is with oxacetylene welding, since the area heated by the electric process is comparatively small. Pre-heating and after-heating, or annealing, is required in many instances to avoid locked up strains and hard lines, for instance when welding cast-iron or medium carbon steel or higher, especially when the mass is so great as to cause rapid cooling. This subject will be discussed more in detail in another article.

The methods to be followed vary in each case. But the practice ordinarily used will be shown in greater detail in the articles devoted to the practice employed for various welds and different conditions. It is necessary, however, to emphasize the fact that the effects of the heat on the structural arrangement of the metal and the phenomena of expansion and contraction are enemies to the welder, and in most cases means must be provided to prevent their effects and avoid their consequences.

Proper Access for the Execution of the Welding Process

To provide proper access for making a weld, the operator must be free to manipulate the arc and be able to incline the electrode to the proper angle with the surfaces on which metal is to be added. Also the beveling, spacing and arrangement of the work must be such as to permit this manipulation and various electrode angles necessary to secure proper fusion through the entire thickness of a weld.

Various Designs of Welds and Types of Joints—Depending on Service Requirements

The names used under the subjects, Type of Joint—Design of Welds—Position of Weld—Kind of Weld, and Type of Weld, are recognized as being proper, and have been made standard by the United States Navy. It is to be hoped that this nomenclature will be used as general practice in order that those interested in the matter will use the same welding terms. This is especially necessary when preparing plans and specifications for those using them in field or shop. Figs. 6 and 7 show the various designs of welds and types of joints to accompany the following:

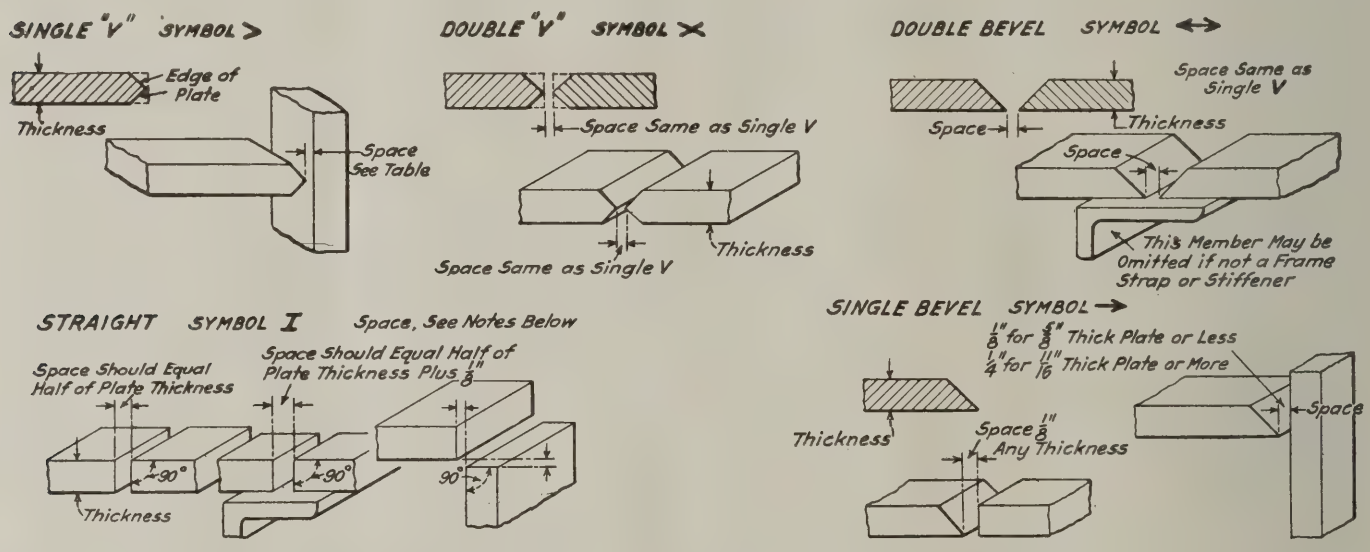


Fig. 6—Designs of Welds Showing Relation of Parts and Spacing

Single "V" is a term applied to the "edge finish" of a plate when the edge is beveled from both sides to an angle, and to be used when the *"V"* side of the plate is to be a maximum "strength" weld, with the plate setting vertically to the face of an adjoining member, and only when the electrode can be applied from both sides of the work.

Note: A 45 degree bevel is the most common angle for a *Single "V"* edge finish. The following table is recommended for spacing indicated in Fig. 7 for *Single "V," Double "V"* and *Double Bevel*:

Thickness Plate	Space
Above 1/16 in. to ⅛ in.	1/32 in.
Above ⅛ in. to ½ in.	⅛ in.
Above ½ in. to ¾ in.	3/16 in.
Above ¾ in.	¼ in.

Double "V" is a term applied to the "edge finish" of two adjoining plates when the adjoining edges of both plates are beveled from both sides to an angle. To be

used when the two plates are to be "butted" together along these two sides for a maximum "strength" weld; only to be used when welding can be performed from both sides of the plate.

Note: A 30 degree bevel is the most common angle for a *Double "V"* edge finish.

Straight is a term applied to the "edge finish" of a plate when this edge is left in its crude or sheared state. Should only be used for thick plates where maximum strength is not essential, or unless used in connection with strap, stiffener or frame, or where it is impossible to otherwise finish the edge. Also to be used for a "strength" weld with plate of not more than 3/16 in. thickness or when the edges of two plates set vertically to each other, as the edge of a box.

Single Bevel is a term applied to the "edge finish" of

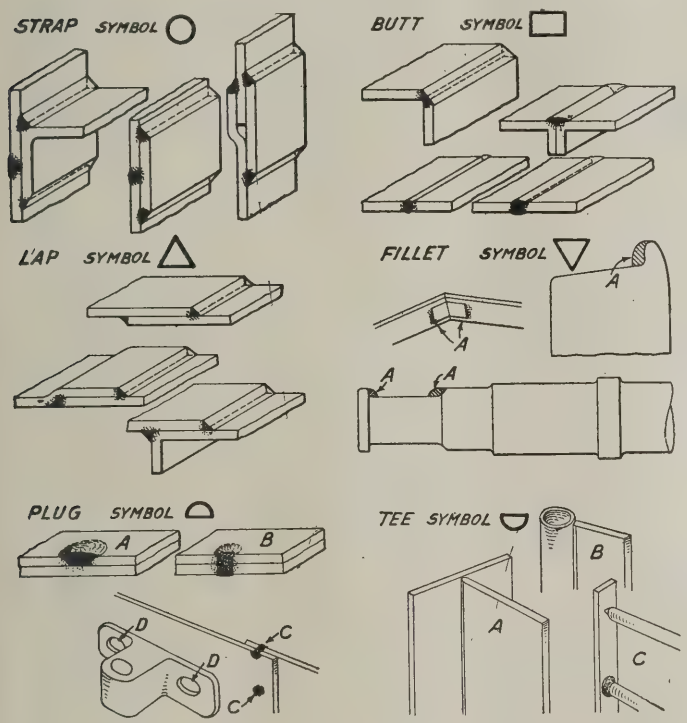


Fig. 7—Types of Joints

a plate, when the edge is beveled from one side only to an angle. To be used for "strength" welding when the electrode can be applied from one side of the plate only, or where it is impossible to finish the adjoining welding surface.

Note: Bevel is the same as *Single "V"* edge finish.

Double Bevel is a term applied to the "edge finish" of two adjoining plates, when the adjoining edges of both plates are beveled from one side only to an angle. To be used where maximum strength is required, and where electrode can be applied from one side of the work only.

Note: Bevel is the same as *Double "V"* edge finish.

Strap weld is one in which the seam of two adjoining plates or surfaces is reinforced by any form or shape to add strength and stability to the joint or plate. In this form of weld the seam can only be welded from the side of the work opposite the reinforcement, and the reinforcement of whatever shape must be welded from the side of the work to which the reinforcement is applied.

Butt weld is one in which two plates or surfaces are brought together edge to edge and welded along the seam thus formed. The two plates when so welded form a perfectly flat plane in themselves, excluding the possible projective caused by other individual objects as frames, straps, stiffeners, etc., or the building up of the weld proper.

Lap weld is one in which the edges of two planes are set one above the other, and the welding material so applied as to bind the edge of one plate to the face of the other plate. In this form of weld the seam or lap forms a raised surface along its entire extent.

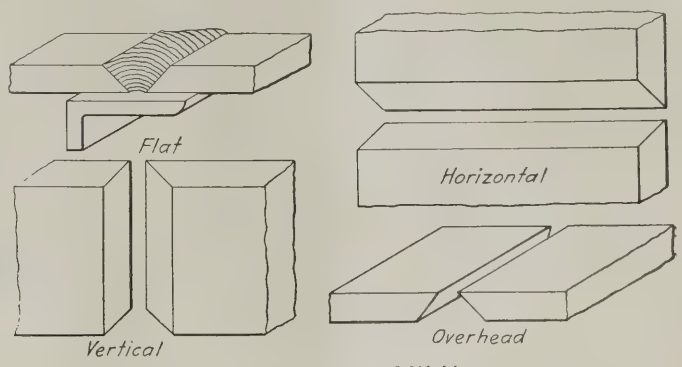


Fig. 8—Position of Welds

Fillet weld is one in which some fixture or member is welded to the face of a plate by welding along the vertical edge of the fixture or member or when metal is added in a corner as indicated—see "welds" shown and marked *A* on illustration. The welding material is applied in the corner thus formed and finished at an angle of 45 degrees to the plate.

Plug weld is used to connect the metals by welding through a hole in one plate as at *A*, or both plates as at *B*; also used for filling through a bolt hole as at *C*, or for added strength when fastening fixtures to the face of

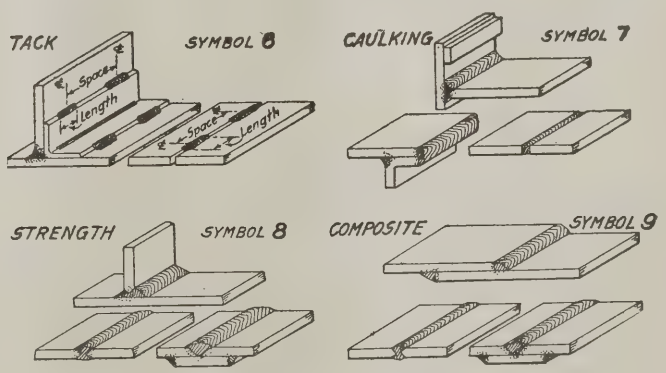


Fig. 9—Kind of Welds

a plate by drilling a countersunk hole through the fixture as at *D* and applying the welding material through the hole, thereby fastening the fixture to the plate.

Tee weld is one where one plate is welded vertically to another as at *A*; also used for welding a rod in a vertical position to a flat surface, as the rung of a ladder, as at *C*, or a plate welded vertically to a pipe stanchion as at *B*.

Position of Weld

The position of a weld is shown in Fig. 8, and is determined as follows:

Flat when the welding material is applied to a surface such that the electrode is held approximately vertical and the metal flows in a downward direction. *Horizontal* when the welding material is applied to a seam, the plane of which is vertical to the floor and the line of weld is parallel with the floor. *Vertical* when the line of weld is perpendicular to a horizontal plane. *Overhead* when the welding material is applied to a surface such that the electrode is held approximately vertical and the metal flows in an upward direction.

Kind of Weld

A *Tack* weld is one where the welding material is applied in small sections to hold two edges together, and should always be specified by giving the space from center of one weld to the center of the next and the length of the weld itself. No particular design of weld is necessary of consideration. A *Tack* weld is also used for temporarily holding material in place that is to be welded solid until the proper alinement and position is obtained, and in this case neither the length, space and design of weld are to be specified. Illustrated in Fig. 9.

A *Caulking* weld is one in which the density of the crystalline metal, used to close up the seam or opening, is such that no possible leakage is visible under a water, oil or air pressure of 25 lb. per square inch. The ultimate strength of a caulking weld is not of material importance, neither is the design of weld of this kind necessary of consideration. The operator must be the judge in the number of layers needed for a tight weld, although the designer should specify a minimum amount of layers. Illustrated in Fig. 9.

A *Strength* weld is one in which the sectional area of the welding material must be so considered that its tensile strength and elongation per square inch must be equal to at least 80 per cent of the ultimate strength per square inch of the surrounding material. (To be determined and specified by the designer.) The welding material can be applied in any number of layers beyond a minimum specified by the designer. The density of the crystalline metals is not of vital importance. The design of weld must be specified by the designer and followed by the operator. Illustrated in Fig. 9.

A *Composite* weld is one in which both the strength and density are of the most vital importance. The strength must be at least as specified for a "strength weld," and the density must meet the requirements of a "caulking weld" both as above defined. The minimum number of layers of welding material must always be specified by the designer, but the operator must be in a position to know if this number should be increased according to the welders' working conditions. Illustrated in Fig. 9.

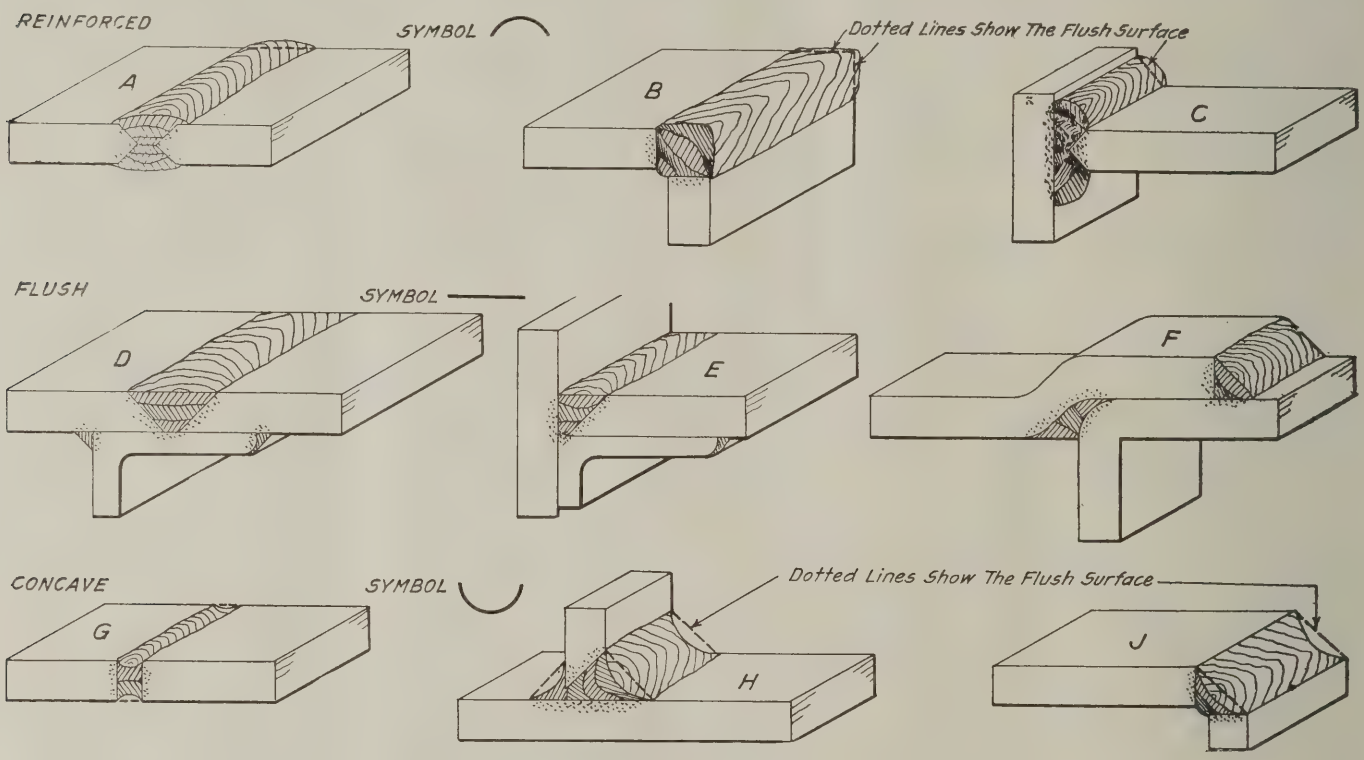


Fig. 10—Type of Weld—Reinforced, Flush and Concave

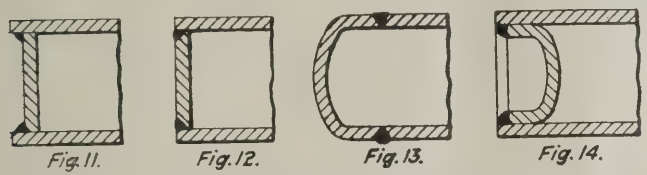
Type of Weld

Reinforced is a term applied to a weld when the top layer of the welding material is built up above the plane of the surrounding material as at *A* or *B* or when used for a corner as at *C*. The top of the final layer should project above a plane which is 45 degrees to the adjoining material. This plane at 45 degrees is shown by the dotted line in *C*. This type of weld is chiefly used in a *strength* or *composite* kind of weld for the purpose of obtaining the maximum strength efficiency, and should be specified by the designer, together with a minimum number of layers of welding material. Illustrated in Fig. 10.

Flush is a term applied to a weld when the top layer is finished perfectly flat or on the same plane as on the adjoining material, as at *D* and *E* or at an angle of 45 degrees when used to connect two surfaces at an angle to each other as at *F* above. This type of weld is to be used where a maximum tensile strength is not important

and must be specified by the designer, together with a minimum number of layers of welding material. Illustrated in Fig. 10.

Concave is a term applied to a weld when the top layer finishes below the plane of the surrounding material as at *G* or beneath a 45 degree plane at an angular connection as at *H* and *J*; this type of weld to be for work of no further importance than filling in a seam or opening, or for strictly caulking purposes, when it is found that a minimum amount of welding material will suffice to sustain a specified pound square inch pressure without leakage. It will not be necessary ordinarily for the designer to specify the number of layers of material, owing to the lack of structural importance. Illustrated in Fig. 10.



Figs. 11 to 14—Preparing Cylinders and Vessels for Welding.

Conditions will determine the design and type of joint that can be used, and the service requirements will determine the kind and type of weld. For example: If a square sheet is to be welded in a locomotive fire box, the vertical seams should be designed for a double bevel and the horizontal seams for a single bevel, with the unbeveled edge below the beveled edges in both cases. In this connection, a good rule to follow is never to remove more of the original material than is necessary to secure fusion through the entire thickness of the parts to be joined. The welding positions in this case would be horizontal and vertical. The butt type of joint would be used. The kind of weld would be a *strength,* and the type of weld, *reinforced.*

In preparing plans embodying welds, symbols may be used, some of which are shown in Figs. 6, 7, 9 and 10, to designate Type of Joint—Design of Weld—Position of Weld—Kind of Weld—and Type of Weld.

Welding of Metal—Thin to Thin and Thin to Heavy

Thin pieces, 3/32 in. and less require no beveling, and in most cases no metal is added. The edges may be butted together, or preferably upturned. They can then be fused together, using a low current with a ½ in. electrode of carbon or graphite approximately 6 in. long tapered to ⅛ in. at the end. A certain amount of skill is required in welding thin pieces, but a little practice will soon enable an operator to do good work. Wire netting, etc., is welded together in the same manner as thin plates. Carbon blocks, pieces of cast iron or copper are used sometimes for a backing to conduct the heat away and prevent the melting away of the edges.

In welding thin pieces to heavy pieces, the conditions will govern the preparation of the work. In some cases this class of welding is more difficult to do than is the welding of parts of equal thickness. In general, however, the electric process is better adapted to such work than any other form of autogenous welding.

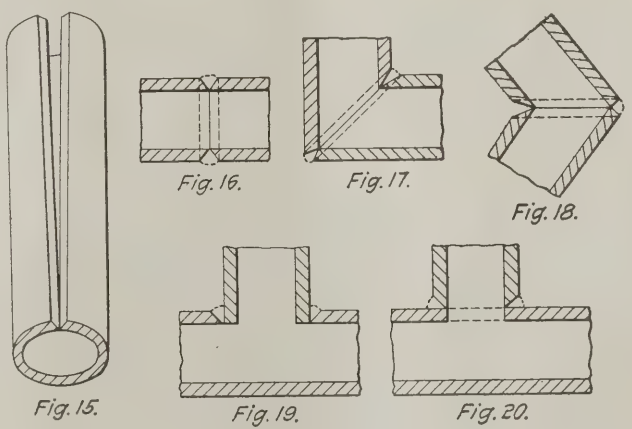
An example of this class of work is to be found in the welding of boiler tubes to the tube sheet. The metallic arc is about the only process commercially used. The thickness of the tubes are usually ⅛ in. and the tube sheet ⅝ in. The heat used must be sufficient to bring the thicker part up to fusion, which will tend to penetrate through the thinner part where the difference in thickness is very great. The work is accomplished by playing the greater portion of the arc's flame on the heavier piece.

Preparation of Cylinders and Vessels for Welding

In general, the preparation of cylinders and vessels upon which welding is to be done will be governed by the service which determines the strains that may be expected to be imposed upon the line of the weld. For vessels that are not to be subjected to high pressures or rough handling, the least expensive method is the most desirable, two examples of which are shown in Figs. 11 and 12. For vessels which is to contain gases or liquids under high pressure, the line of weld should be one of tension or compression, and not a prying or binding one. A butt-weld head of good design with the weld in tension is shown in Fig. 13. A concave head with the weld in compression is shown in Fig. 14, which is by far the better and stronger construction. Vessels having heads welded in as shown in Fig. 14 have been subjected to a pressure of 3,600 lb. before rupture occurred.

Longitudinal Seams and the Preparation of Pipes and Tubes for Welding

In welding longitudinal seams on round tanks, it is first necessary to have a perfectly round shell; that is, the joining ends of the sheet should not have a flattened section, as is customary when coming from the bending rolls. A flat surface along the line of weld has a tendency to round out under pressure, and in so doing places a bending strain on the weld, which is often the cause of rupture. The "edge finish" would be beveled and a butt type of joint used. The contraction can be allowed for by a greater separation at one end than at the other as shown in Fig. 15. The amount of opening should be determined as previously explained.



Figs. 15 to 20—Preparation of Longitudinal Seams, Pipes and Tubes for Welding

In joining pipes together so as to form a straight piece the ends should be beveled as shown in Fig. 16. Pipes that are to be joined to form angles should have the ends prepared as shown in Figs. 17 and 18. Branches should be prepared as shown in Figs. 19 and 20. Many pipe fittings of various kinds are constructed by the arc

process, and their preparation is governed largely by service requirements and the conditions under which the operator must work.

THE SWISS RAILWAYS EXTEND ELECTRIFICATION

The introduction of electric traction on the lines of the Swiss Federal Railways has, on account of the acute shortage of coal occasioned by the war, received the foremost attention of the authorities and has now emerged as a very practical economic question.

The principal arteries of the Swiss railway system are government owned. The electrification of these lines is simplified by the large amount of unused water power which the country possesses. According to an official survey, verified in 1914, including the improvement and water level control of lakes, the water power of Switzerland is capable of producing an energy equal to 2,173,000 h. p. If old plants were replaced by new ones it is even estimated that the total water power could be raised to as much as 8,000,000 h. p. On January 1, 1914, the electric power already in use in Switzerland amounted to 887,000 h. p.

The Swiss Confederation owns some 1800 miles of the entire railway system of the country which covers 3216 miles. Of the 1416 miles owned by private companies 622 miles are already electrical, but only an insignificant percentage of the government railroads is at present operated by electricity.

The first important federal standard-gage road to be chosen for electrification was the Gothard Railway, one of the important international highways. The electrification of the 68-mile section Erstfeld-Bellinzona was approved in 1913 and it is expected that it will be opened this fall. This section, with 28 per cent of its length consisting of tunnels and a grade of 2.5 to 2.7 per cent for 25 miles, was chosen for an experiment because of its enormous traffic with Italy, which caused large consumption of coal with resulting smoke in the tunnels.

The sections Bellinzona-Chiasso and Erstfeld-Lucerne are expected to follow in 1921 and the consulting experts have found that the big power stations at Amsteg and Ritom, the first yielding 26,000 h. p. and the latter 32,000 h. p., will also suffice for these lines, even if the traffic should increase some 60 or 70 per cent. Another series of plants yielding 70,000 h.p. is planned.

The cost of electrification of the Erstfeld-Bellinzona line is estimated at $8,000,000. The cost of electrifying the entire federal railway system is estimated roughly at $200,000,000.

In 1918 the electrification of the following railways using steam traction was decided upon and work on them commenced at once: the sections of the Federal Railroad Sion-Brigue and Berne-Thun; the section Hasle-Langnau of the Emmenthal Railroad and the section Bevers-Filisur of the Rhaetian Railroads.

The electrified Berne-Thun line, connecting with the electric Berne-Lötschberg-Simplon railway, which latter was inaugurated in 1913, was opened for traffic last May. It now provides excellent and frequent train connections between the Swiss capital, the Bernese Oberland resorts and—in connection with the Lötschberg line—the Valais and Northern Italy.

The new locomotives which are now being used by the Swiss Federal Railroads on the Berne-Thun section, besides those of the Berne-Lötschberg-Simplon line, are each equipped with four single phase-alternate current motors, each of 450 h.p. The electric parts were furnished by Brown-Boveri & Co., Baden, and the mechanical parts by the Swiss Locomotive & Machine Company.

The electrification works on the Bevers-Filisur line were completed by middle of last April and since April 16 steam locomotives have been replaced by electric locomotives, the current being supplied by the power station of Bevers, which furnishes the necessary energy for the Engadine lines which were electrified in 1913.

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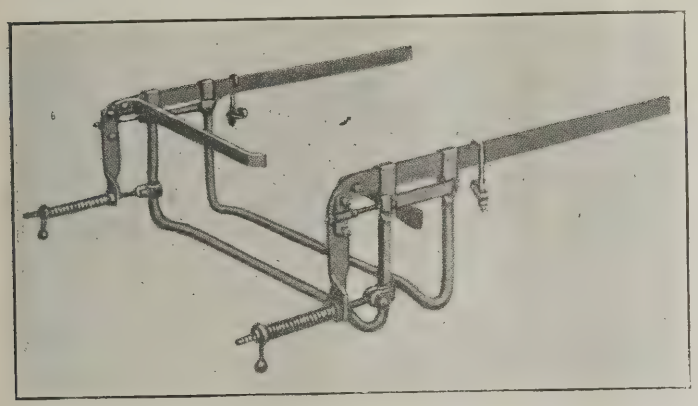
Scenes from Foreign Ports—On the Water Front at Goteborg, Sweden

Why One Road Changed Its Generator Suspension

The Method Adopted Adds Life to Equipment, Gives Better Alinement and Keeps Maintenance Low

By J. H. Burcham*

THE success and service life of car lighting equipment depends upon many factors, all of which must be watched carefully in order to avoid failures, which in some cases may be prevented by using proper precautions. The Chicago & Eastern Illinois is one of the roads that have been watching their car lighting equipment in order to detect conditions that may cause failures, thus permitting the necessary adjustments and repairs to be made before failures actually occur. One of the things this road has done, which has helped to improve its car lighting conditions, reduce its maintenance costs and add service life to a certain type of its axle generator equipment, has been the adoption of what it considers a better method of suspending old Bliss truck hung axle equipment. The new arrangement is particularly effective where this equipment, hung in the original way, begins to show signs of wear on certain parts, which if allowed to remain in such condition might lead to a continuous source of trouble and failure in service.



View showing Old Method of Suspending Bliss Generator

Reasons for Adopting a New Method of Suspension

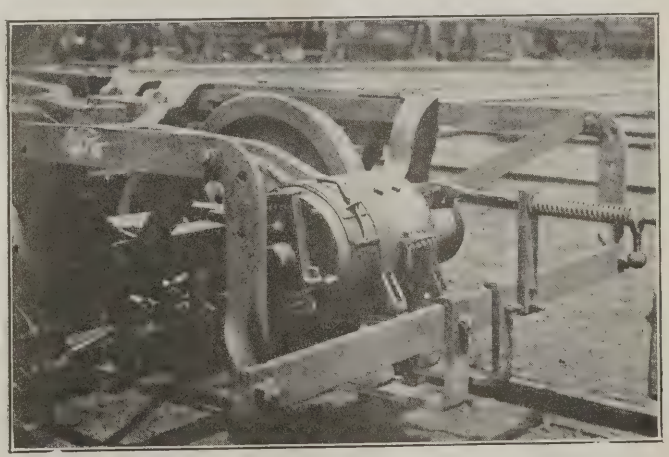
The adoption of a new method of axle generator suspension came about in the following manner: Referring to the illustration showing the old method of supporting a Bliss generator on two U-bars, which are hung on side bars fastened to the truck frame, it will be noted that the feet of the generator frame are subject to considerable wear on account of the turning or twisting effect of the U-bars on which the generator rests. If the feet become worn to any great extent it is impossible to get more than three of them to touch the U-bars at the same time. The result is, that in most cases when the generator is clamped to the U-bars, instead of it being bolted down evenly, it is clamped in such a way as to prevent the necessary, free rocking motion to the suspension.

When these conditions were discovered, various schemes were tried to overcome the trouble. It was found that even though bushings were inserted in the worn parts, the troubles described above would soon reappear and if the equipment was allowed to remain in service under such conditions it would only be a question of time before the wear on the generator would be such as to require an entirely new frame, or the legs repaired by some kind of a welding process.

The New Method of Suspension

In order to overcome the objections mentioned above it seemed advisable to design a new method of support. As a result of study and investigation the support shown in the other illustrations is the one now in use. It has proved a worthy successor to the old suspension as far as the Chicago & Eastern Illinois is concerned. It has increased the belt mileage and better alinement of generator and axle pulleys can be maintained. There is only one belt tension device, whereas formerly two were required. Furthermore there is plenty of room to work around the generator, there being nothing in the way except the belt tension rod.

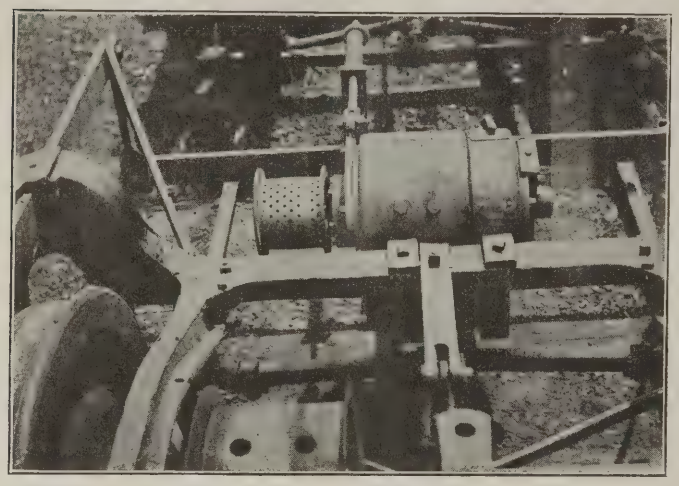
Referring to the photographic reproductions showing the new method of support, it will be observed that the old Bliss side bars are still in use. At the lower end of these bars, connecting the two together is a one inch by four inch iron bar, to which is fastened two other iron bars called "bales." These bales which are fastened to the end sill of the truck and the horizontal bar between the old Bliss side bars furnish a means of support for the generator. Upon each bale is a Consolidated type "D" bale shoe, and to the feet of the generator are fastened cast steel rocker shoes. The horizontal bar, the bale and the cast steel shoe are shown in one of the illustrations.



View Showing Old Side Bars and Application of Horizontal Bar, Bales and Tension Device

* Chief Electrician, Chicago & Eastern Illinois.

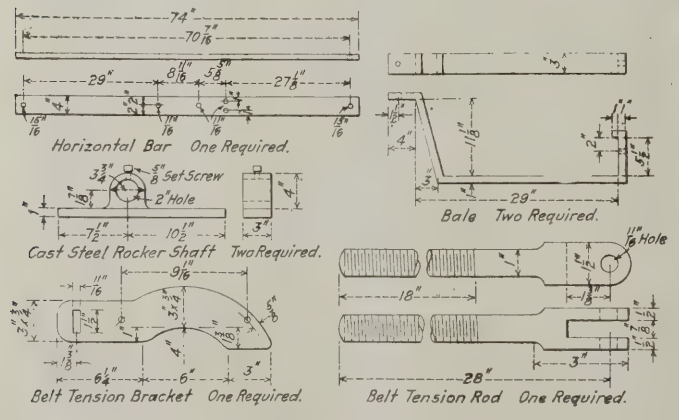
The rocker shoes and bale shoes are so located with respect to one another as to permit a two-inch rocker shaft, which is fastened rigidly into the rocker shoes, to fit into openings in the bale shoes. It is quite evident, since the rocker shaft is held rigid in the rocker shoes, which are fastened to the feet of the generator, that there is no turning or wearing condition in the rocker shoes or rocker shaft at those points. It



View Showing Bales Fastened to End Frame of Truck. Belt Tension Device and Axle Pulley

is only in the bale shoes, where the rocker shaft is free to move that any wear takes place and it may occur on either or both the rocker shaft and bale shoes. It is an easy matter, however, to remove the bale shoes, which are standard repair parts, or the rocker shaft.

An important feature in the design of the rocker shoe, is that the hole for the rocker shaft is out of center with respect to the center of gravity of the generator when the rocker shoes are fastened to the feet of the generator. The reason for this off center condition is to take care of the situation as the belt stretches; that is, the weight of the generator lies against the belt and



Special Parts for C. & E. I. Bliss Generator Suspension

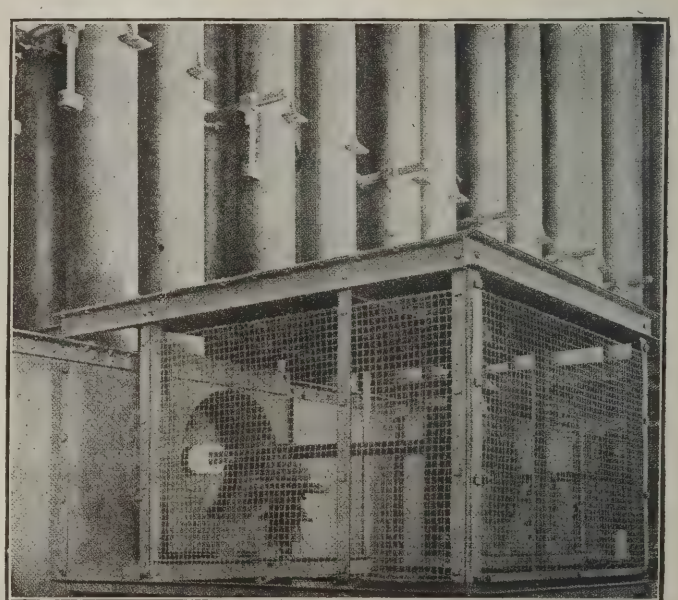
as the belt stretches the generator falls back more and more because of its weight. This feature permits a greater belt stretch than in the former method of support.

The belt tension device consists of a piece of ¾ in. by 3 in. iron which is shown in one of the illustrations. This part is bolted to the generator frame by means of two of the bolts which also hold the pulley-end housing to the generator. Extending from the end of this iron plate is the extension rod, spring and wrench; practically all of which are parts of the old equipment. The only change is the addition of a fork or jaw connection welded on the rod opposite the threaded end. This belt tension rod passes through a loose fitting iron bushing which fits into a 1¾ in. hole in an iron bar ¾ in. by 3 in. cut to the proper length and fastened to the 1 in. by 4 in. iron cross bar between the old Bliss side bars.

The belt tension bracket, the belt tension rod and the steel rocker shoe are the same for all cars equipped with this type of suspension. But the overall dimensions for the bales and the horizontal iron bar vary according to the class of cars they are installed on.

PRECIPITATION OF SOLIDS FROM SMOKE AND GASES

In their circular No. 7375 the Westinghouse Electric & Manufacturing Company has described an electrical method for recovering valuable material from smoke and gases. The system involves the use of a considerable



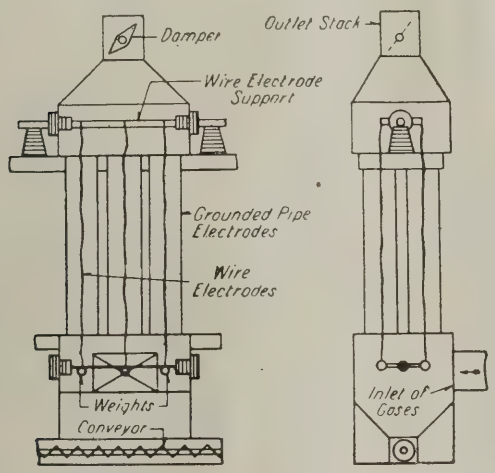
Treater Installed at the Plant of the International Smelting Company, Miami, Arizona, Showing Vertical Pipes and Hammers for Loosening Deposits

amount of electrical apparatus, but it is quite simple, has proved very successful and may find its application in roundhouses and railroad powerhouses in large cities. Up to the present time its application has been limited to smelters and cement plants and, in most cases, the by-products collected by the precipitation have paid for the necessary equipment in a very short time.

A treater for electrical precipitation is a comparatively simple structure. In general it consists of two large horizontal flues connected together by a number of small vertical pipes. Gases enter through one flue, pass through the vertical pipes and are discharged through the other flue to the stack, exhaust fan or other draft producer. The gas is then exhausted into the atmosphere. Some treaters are operated with an up draft, some with the down draft, according to the particular local conditions to be met. Some treaters employ rectangular passages instead of pipes to connect the two

flues. These are generally referred to as plate or box type treaters. The principle of operation for all these types of treaters is the same.

The actual precipitation of a gas or fume occurs in the vertical pipes referred to above. Centered carefully in each, is suspended a small wire or chain. These constitute the negative electrodes of the treater system. The inside surface of the pipes constitutes a positive electrode. Each wire or chain is carefully insulated from its pipe and from the ground and is charged to a potential of from 25,000 to 65,000 volts direct current. The tubes themselves are grounded. Thus within each pipe is created an intense electrostatic field. The gases passing through this field become ionized and the ions travel with high velocity in a direction at right angles to the electrode causing the field. These highly charged ions collide with the suspended solid and liquid particles in the gas and the ions impart a charge of high potential to such particles, which in turn travel toward the electrode of opposite polarity. Since the negative suspended electrode is of much smaller area than the electrode formed by the inside surface of the pipe, there is much greater



Schematic Diagram of Treater

electrostatic stresses per unit of area in the neighborhood of the wire, and as a result a far greater ionization about the wires. Thus, the gas receives a static charge of the same polarity as the wire, and the solid or liquid particles in the gas receive charges of this same polarity, which causes them to be projected against the inner surface of the pipe, where they tend to stick and accumulate until the electric power is turned off, after which the accumulation of dust is usually collected from the pipe by rapping the sides of the pipe and collecting the dust in hoppers at the bottom.

The treater tubes are usually arranged in a series of units. Each unit or section is independent of the rest and is supplied with dampers and electrical disconnecting switches, so that it can be shut down for cleaning or repairs without interfering with the operation of the other sections.

To produce the high static charge on the suspended electrodes a uni-directional current of high voltage is used. Alternating current at low voltage is stepped up to the desired high voltage by means of a transformer and then changed to a uni-directional current by means of a mechanically driven rectifier. Accordingly, in addition to the necessary flues, tubes and high tension electrodes, the usual equipment for electrical precipitation involves the following: A source of low voltage alternating current, a step-up transformer, a high voltage rectifier, means for driving the rectifier, a switchboard and accessories.

This apparatus must be of special design and construction in order to be suitable for this service, but it is all of familiar type except the rectifier. Several different types of rectifiers have been developed, but the one generally used is the mechanical disc-type commutator. Another, known as the arm-type, is sometimes used when heavy currents are rectified. The rectifier is driven in synchronism with the high-voltage alternating current either by being mounted on the shaft of the generator supplying the low-voltage alternating current or by being driven by a synchronous motor operated from the low-voltage circuit. Its principle of operation is the same as that of the commutator of a direct-current generator.

Owing to the continual interruption of the high-voltage circuit by the rectifier, there is a tendency to set up high-potential and high-frequency oscillations, which interfere with the operation of the treater, endanger the insulation of the transformer end-coils, and sometimes are reflected back through the transformer into the low-voltage apparatus. In order to eliminate these oscillations as far as possible and to smooth out those that cannot be eliminated, inductance and resistance are usually inserted between the transformer and the treater, but even this precaution does not entirely do away with these oscillations, and the electrical apparatus, both high and low-voltage, must be built to withstand them so that it can give satisfactory service.

The voltage of the high-voltage treater-current that will give the most satisfactory results depends upon a number of factors, including the characteristics of the individual treater, the character, temperature and velocity of the gases being treated, and the barometric conditions of the atmosphere. As many of these factors are variable, some means of controlling the voltage must be provided in order to meet changed conditions. Large adjustments of voltage are secured by means of several taps in the low-voltage windings of the transformer, which provide a range of from 50 to 100 per cent of the rated high-voltage of the transformer. Smaller adjustments of the voltage obtained on each of these taps are secured by varying the voltage of the low-voltage alternating current supplied to the transformer.

Skill is Rewarded.—Members of the National Founders' Association, with headquarters in Chicago, tell this little story on the railroad administration: "Down on the Wabash line a water tank was operated by electricity which was tended by a nearby farmer. He turned on the switch in the morning, went about his own business, came back about six o'clock and turned it off. For this service of a few minutes each day he received about $20 a month. When the railroad administration took hold, those classifying employees rated this farmer as an electrician. They figured his time for the entire day and allowed him about $300 a month, without, however, requiring any additional work from him. Furthermore, he was given back pay to the amount of $2,500 or $3,000."—*Iron Trade Review.*

Trials and Troubles of a Car Lighting Man

Hinkey Dee Takes a Vacation and Tries to Demonstrate His Skill With Strange Equipments

I GUESS I shouldn't get discouraged, but it seems to me when a feller knows all about car lightin' like me and works in the carlightin' department on a railroad, the more interest he takes in his work the less credit he gets. The last time I went to Palm Beach on me vacation I thought I'd keep up the good name of Hinkey Dee and at the same time look after the interest of all the railroads. So, while I was ridin' over the different roads I give each car lightin' equipment a real good inspection.

The first train I inspected was on a night run and I opened the switchboard and regulator lockers on each car, pulled everything up and down I could find movable to see it wasn't stuck, I also raised the lamp regulator arm up and down a few times and what do you think? After I did all of this for nothin'—mind you, I wasn't bein' paid for it—the conductor got so mad at me he was goin' to throw me off the train. He said, "Who are you?" I said, "Why, I'm Hinkey Dee the carlightin' expert!" He said, "Well, I don't care who you are, if you don't stop bouncing those lights up and down while I'm trying to collect these tickets I'll bounce you off the train." Now wouldn't that get your goat! I said, "Well, if you don't want your lights looked over by a man who knows 'em from the letter *A* to the letter *Z* then I'll not be responsible for them." Then to make matters worse he took me name and number of me pass and said he was going to write me up. So I just beat him to it, I got a blank and sent a telegram to the boss which read as follows:

"Dear Boss,

"All the trains I have been on since I started on me vacation "is all rite and if any body says anything is, I say it ain't.

"Yours respeckterly,

"Hinkey Dee.

"P. S. If you can't get along without me let me know and I'll "come rite back."

The following night I was ridin' on a train but I couldn't find any regulators. So I asked the brakeman about it and he said all the electricity was in the baggage car and come from the engine and had wires on each car looped together and the juice run up over the roof. So I looked and sure enough there was a steam engine in the baggage car that looked like a hydraulic pump for an elevator and was runnin' the funniest lookin' axle generator I ever saw and the man who made it was named Steam Turbine because his name was on the name plate in front. I looked it over and tried some things to see if they worked or not and somethin' wasn't workin' right because springs, valves and iron bolts started to fly and all the lights on the train went out. Gosh, I got away real quick! The conductor seemed worried so I thought I'd help him out. We got 300 candles and 600 matches put on at the next station and me and the conductor gave each passenger a candle and two matches, but believe me or not I spent six weeks in court answerin' questions about how, when, where and why we used candles. Everybody on the train sued the company. One old feller said the candle set his whiskers on fire. A lady said the candle burned the canary off her hat. Another man said he got candle grease all over his clothes. Another lady said there was so much candle smoke in the cars that she had sore eyes ever since, and what do you think the conductor said—now just listen to this—he said the lights were all right until I started to monkey with them. By Golly, there's no use workin' hard and takin' an interest in your work anyway.

The next train I rode on was runnin' in daylight, so I tried all the lights on each car and found a car with one

Before I could explain he fired a suit case at me. I ducked and it hit a lady in the seat opposite and knocked her off her seat.

lamp that wouldn't light. The conductor told me not to bother with it but I told him that they didn't do business that way on the railroad where I worked and that everythin' was fixed and fixed right. So I took the lamp out and tried a new lamp, but it still wouldn't light so I got a ladder and took the socket apart. When I pulled the socket out of the fixture a big bunch of dirt and cinders fell down all over the passengers. One old crab said, "Hey, what in the world are you trying to do?" I said, "Why fix this light, what did you think I was tryin' to do, ride a bicycle?" Just then the train stopped suddenly

and I fell off the ladder and landed square on the old crab's lap. By Gingoes he got mad! Before I could explain he fired a suitcase at me. I ducked and it hit a lady in the seat opposite and knocked her off her seat. Then he wanted me to take the blame for it! But I explained to him in a sharp tone of voice that I was Hinkey Dee the car lightin' expert and was no fool. Finally the conductor came along and then there was some tall writin' and oh, I didn't have time to fool any more so I finished me job, but couldn't get the lamps to light. I explained to the conductor that the trouble must be somewhere I

The Conductor started to run and tripped over a foot some fellow had sticking out in the aisle and fell on his chin.

hadn't looked and what do you think he said! He said, "Who are you?" I said, "Why I'm Hinkey Dee the car lightin' expert." He said, "Young feller, you may be a car lightin' expert but I think if you come around to my house next fourth of July the children will need you, why you're punk!" Now wouldn't that discourage you? After me tryin' to help him out! Oh, what's the use of bein' good.

Then I changed trains and found a car in this train with dim lights. The conductor said the electrician had taken the belt off on purpose. I looked at a tag on the switchboard and it said: *"Do Not Apply Belt, Armature in Trouble."* I said to myself, "That's all foolishness." I hunted up the conductor and he said he'd have a belt put on if I said so. I found the belt that had been removed inside the car and so I told the conductor if he'd stop the train I'd put the belt on meself. So he stopped the train and I put the belt on all by meself. The train started and the lights came up nice and bright. I smiled to meself and told the conductor that these electricians think they know it all, but I can show them a thing or two. Just then smoke started to roll in from under the car. Two fellers sitting in the middle of the car stopped the conductor and told him that if the smoke kept getting worse they'd need a gas mask. I told the conductor it must be a hot box but he said "No, it's that blame thing you put the belt on." The train kept runnin' and the smoke kept on comin' in the car and was flyin' all around outside of the car. A towerman stopped the train and said there was so much smoke comin' from the car that he couldn't tell it from the engine. I cut the belt off for the conductor and told him in all my years of car lightin' experience I never saw a machine act like that and that I still didn't believe it was armature trouble. The conductor grumbled something and walked away. I guess he was thankin' me for takin' off the belt.

After leavin' that train I boarded a real train. Yes, by golly, I never saw a train in all my years of car lightin' that was so well lighted. I congratulated the conductor on the method of lightin' and told him he had a train he should be proud of. He told me that he had conducted the train for twelve years and never had any trouble with the lights. Then he asked me who I was. I told him and he seemed pleased to meet me. He was such a different kind of a feller from the average conductor that I decided to give him some knowledge about car lightin'. So I said, "Say, young feller, would you like to know somethin' about car lightin'? If you do I'm just the feller who can put you right." "Yes I would," said the conductor, "I would like to know how these lights work." So I told him to come to the switchboard and regulators with me. I moved the arm so as to cut out the generator and the green pilot lamps over the door exploded and the main generator fuse blew. The lamp exploded with a sharp green flash and a bang. The conductor started to run and tripped over a foot some feller had sticking out in the aisle and fell on his chin. But I stuck to me post. It was a different lookin' regulator panel so I guessed that somethin' must have went wrong just as I moved the generator regulator arm. The conductor got all nervous and wouldn't come near the regulator. So I made up me mind to see if the other cars were workin' all right and what do you think? I tried every car on the train and every car exploded the pilot lamp and blew the main fuse. The conductor telegraphed for an electrician to meet the train at the next station. I told the conductor that somebody must be bad luck, everythin' goin' wrong at once. At the next station the electrician got on and put new fuses and pilot lamps and everything worked fine. Then I said, "Well, young feller, what was wrong?" "Why I couldn't find anythin," he said, "that would cause the fuse to blow. I guess someone has been monkeying with these cars." "Right you be," said the conductor, "and here's your man," pointin' to me. Then I got mad and I told the electrician that I knew more about car lightin' than anybody and to prove to him that I was good and knew me business I'd move the arm same as I did before to cut out the generator, and when I did, by golly, if the pilot lamp didn't bust and the fuse blew. "Stop," yelled the electrician, "gracious, what do you mean, are you trying to put things on the blink?" I said, "Why you big fool I opened the field carbons to cut out the generator." Then the electrician laughed and laughed and laughed and I got mad. I said, "Lookahere, don't you laugh at me."

The electrician stopped laughin' and said, "Say, Hinkey Dee, or whatever your name is, take my advice and keep your hands off things you don't understand." "Why," he said, "you poor boob, this is a Moskowitz equipment and the action of the field pile has the opposite effect from other equipments; You wooden head, it's in multiple with the field coils instead of in series."

I told him I knew as much about it as he did and when I got back home from my vacation I was goin' to look it up and if he was wron', believe me, he was goin' to hear from Hinkey Dee.

LOOKING BACKWARD

An Interview With an Old Car Lighting Foreman

When I first began car lighting work Hinkey Dee would have been considered an electrical engineer considering the conditions that I ran up against. One of the worst things that marked those early days was the lack of records. We had absolutely no records of any kind—no records of the number of equipments, types, output or capacity of machines. The methods for setting the automatic switch on the old Consolidated car lighting equipment were most perfunctory. No such thing as a voltmeter was ever used and the switch was set by a hit-and-miss manner which indeed was no real setting at all.

In order to determine whether a battery required flushing, the car lighting men waited until the cell leaked, or until the solution was entirely gassed out of the battery. They used parallel batteries in those days, but the scheme never worked out well. Old rubber jars cracked on one side would open up the circuit by the solution leaking out and due to lack of inspection the fault would never be discovered until the other side of the battery came into trouble also.

The method of cleaning the batteries was to remove them from the car, carefully pour out the solution together with a fair percentage of brass nuts and washers, being careful not to lose any, lay the cells upon the side, and if we could not see from the top that the plates were useless they were not renewed. In washing the plates we simply took a hose and turned the water in every month or two, after which we stood the cell up and poured back the various colored acids that came out of it in the first place, minus the bolts and nuts. Such things as charging and discharging batteries were unheard of. We never took gravity readings and never paid any attention to sulphation. The batteries were filled up, put back in the cars, connected up and turned loose until further trouble was encountered.

Generators were never overhauled except when they broke down on account of the armature dropping on the pole or due to burned out field coils or similar trouble. This all took place some 12 or 13 years ago. At that time there was no literature describing the operation of the system and no information was available concerning the construction, circuits, etc. of the various types. Out of seven types of systems that we had in service a wiring diagram of only one type was on hand.

The old carbon lamp was the standard lamp of that time. These lamps overloaded the equipment to such an extent that cars operating on night runs could not hold up even though the system was working to its full capacity. The efficiency of the lighting depended upon the amount of daylight running that the cars got, the charging going on in the daytime as well as at night.

Along about 1910 the advent of the tungsten lamp was the first big step forward. It reduced the load on the cars to such an extent that the old equipment was capable of holding it up satisfactorily. After a short trial these lamps were made standard. Conditions have been very much improved in the matter of record keeping, routine work and periodical inspection as well as overhauling the entire equipment. Batteries and equipment in general for the first time were operated with a fair measure of success, even with the unsatisfactory equipment available in those days.

Another big step forward was taken at the time the regulators operating on the taper charge principle were put into operation. These were larger than those in service having ample capacity to hold the light load and battery up to requirements. This increased life of the batteries resulted in the elimination of overcharge and the fact that the generator being able to give sufficient output to carry the heaviest load, reduced the ampere hours required from the battery to such an extent that the battery assumed the role of stand-by operation instead of being called on to furnish part of the current required when the full light load was on. Battery life of the positive plates jumped from a year and a half to 5 years and in some cases even more.

About this time the rubber battery jars were discarded and double compartment wooden trays with lead lining were adopted which effected great saving in the cost of battery maintenance as well as giving much better service.

Up to this time generators were subject to many faults, the most common of which was bearing trouble. Oil-ringed bearings were used, but the greater part of the oil escaped from the boxes and ran inside the generator, breaking down insulation, blackening commutators and causing burn outs. Bearings rarely lasted a year and a half in through service due to the amount of belt tension, grit and dirt getting into the boxes, being carried up by the rings into the journal and causing them to run hot. Oil ringed lubrication was superseded by the method of packing boxes with waste which helped matters to some extent, but due to the glazing of the strands required frequent renewals of waste and repacking of boxes.

In 1912, ball bearings were adopted and practically solved the problem of generator maintenance. As soon as their adoption was general, burnt commutators, burnt-out field coils, armatures on poles, dirty machines both inside and out, became things of the past and the necessity for frequent inspection practically disappeared. Generators now are given a thorough inspection once in nine months and a thorough overhauling when the car is shopped. This shopping period varies from 15 months to 2 years. Aside from this the generator is not opened for inspection unless absolute trouble develops, causing it to become inoperative.

In the old days I have worked 50 hours at a stretch and sometimes more trying to make the equipment perform its duty, but those days may be considered as a thing of the past and the fight to maintain efficient car lighting service is practically won.

Railroad Electrification Facts and Factors

Auxiliary Apparatus Required in the Locomotive in Addition to the Main Driving Motors

By A. J. Manson*

In this series dealing with the construction of the electric locomotive and the various parts which make up the complete unit we have covered the construction and design of the pantograph trolley, also the third rail shoe, and have shown how these parts are interconnected. In other words, the apparatus mounted on the outside of the locomotive has been described in detail, and we will now take up the apparatus inside.

Again the locomotives divide themselves into two classes, namely, those operating on alternating current and those on direct current. While much of the control apparatus is similar in the two classes, there is a decided difference in the scheme of control. We will first consider the high voltage a. c. locomotive and then the direct current locomotive and point out in the description of the latter wherein the control differs.

The high voltage alternating single phase current is carried from the pantograph to an oil circuit breaker which we have described. The high tension circuit breaker is used to connect the power to a transformer, or transformers, as the case may be, these transformers being used to step down the high voltage, usually 11,000 volts, to a voltage suitable for the motors and auxiliary apparatus; the auxiliary apparatus consisting of the compressor, the blower and the lights. The construction of the transformer is not radically different from any transformer. However, it has to meet a different condition than does the industrial transformer in that it is subjected to voltage surges, incidental to locomotive operation, and also to moisture where the air-cooled type is used. Heavier insulation must be used on the outside coils and greater creepage distances must be allowed to prevent failure under railroad operation. A few locomotives have been equipped with oil-cooled transformers, but the air-cooled type is generally used. The transformer is enclosed in a sheet iron case, and the air enters at one end and passes out at the other. In order to prevent the transformer from overheating at the coils inside of the iron, ducts are provided between the coils so that the air can pass through these ducts and carry away the heat.

There are two types of transformers used in connection with locomotives, namely, the auto-transformer and the double coil transformer. The auto-transformer was first used universally, but lately the double coil transformer has been generally adopted. The auto-transformer has all of the coils, both primary and secondary, connected together. The high voltage, say 11,000 volts, is connected to the high tension end, and the other end of the transformer is connected to the ground. Starting in at the trolley end we have 11,000 volts. If it was possible to follow down along the coils and measure the voltage we would get a lower and lower voltage, according to the distance from the high tension end, until we reached the ground connection when the voltage is zero. It is therefore possible to get any voltage desired from 11,000 to 0 volts by bringing out a lead known as a tap.

The double coil transformer, as the name suggests, has two sets of coils, a high tension set and a low tension set which do not connect. The high voltage coils are connected between the 11,000 volts and ground, while the low voltage windings are entirely separate and the current is generated in the winding by induction.

The auxiliary apparatus on either type of locomotive consists of a compressor, a blower and lights. There may be more than one compressor and one blower, and it is quite general practice to use two of each. The compressor is the air pump of the electric locomotive. It consists of an air pump of two or more cylinders driven by an electric motor. Power is connected to the motor by a switch thrown by hand. The operation of the pump is controlled automatically by the governor. This governor cuts in and out, depending upon the air pressure in the main reservoir, and makes or breaks the circuit to the electric motor. The operation of the compressor differs from the air pump used on a steam locomotive. The steam air pump maintains practically a constant pressure and operates, pumping air, to maintain this pressure with the slightest reduction. In the case of the compressor, the pressure is not maintained at a constant value, but varies between a maximum and a minimum, usually a variation of 10 lb. For instance, the governor is set at a 10 lb. range, and on locomotives with the feed valve set for 110 lb. train line pressure, the governor would be set to "cut-in" at 120 lb. and to "cut-out" at 130 lb. With this arrangement the compressor is not pumping continuously, but about 50 per cent of the time.

Above was mentioned a blower as one of the auxiliary parts. Most electric locomotives are equipped with motor-driven blowers. They are used for furnishing air to the main motors, transformers and any other apparatus which it is desired to cool. The capacity of the electric motors and other electrical apparatus is determined by the temperature of the apparatus when operating under load. The passing of air through the electrical equipment carries away the heat and allows greater work to be done, which means more electric current. With the installation and use of the blowers the capacity of the electric locomotive for the same weight and cost can be increased by an amount (within certain limits), depending upon the cubic feet of air blown through the apparatus. It is easily possible to increase the capacity by ventilation over 50 per cent. The air is conducted to the various pieces of apparatus from the blower through ducts built into the flooring and framework of the locomotive. Two blowers are used on many locomotives so as to keep the blower outfit to a reasonable size, and also to give a better air distribution to the various parts. When more than one blower is used, both blow into the

*Westinghouse Electric & Manufacturing Company, New York.

same duct system. The power is connected to and cut off from the blower motors usually by means of small hand-operated enclosed switches known as canopy switches the same as used in connection with the compressor. It is necessary to have these switches closed for operation, even though the power is on the locomotive. In addition to the canopy switches an enclosed fuse is inserted in the circuit so that power will be cut off from these auxiliaries in case of trouble as generally the canopy switches are not automatic, and thus will not open although the motor may become grounded.

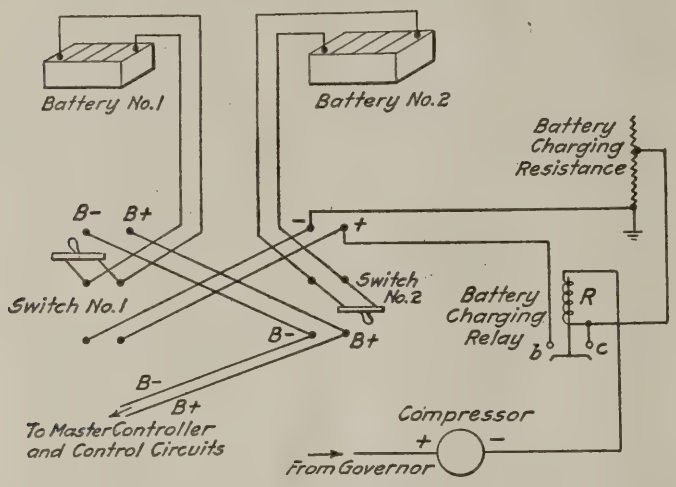


Fig. 1—Battery Charging Connections Used on Direct Current Locomotive

The first locomotives were operated similar to a trolley car in that the main leads from the motors were run to a controller in the engineer's cab. The circuits were made and broken in this controller as well as the motor combinations, so that the main currents were handled by fingers sliding over drum contacts. This arrangement in connection with trolley cars is entirely satisfactory, but is far from satisfactory for locomotive operation. In fact, with the growth of the locomotive to larger and larger sizes some other method was necessary. The enormous currents used today by electric locomotives require a large amount of apparatus to connect the current to the motors and to provide a means for connecting the motors in the proper combinations for operation forward and backward at different speeds. It is designated as control apparatus. Moreover, it must be under the control of the engineer, located at the head end, so that some form of remote control must be used.

There are two distinct systems which have been used to date:

(a) The electro-pneumatic system.
(b) The electro-magnetic system.

The electro-pneumatic system has been developed by the Westinghouse Electric Co. and has been used extensively in the locomotives built by them. This system is in use in all of the locomotives on the N. Y., N. H. & H. R. R., the P. R. R., the Norfolk & Western and many others.

The principle used in the operation of this system is this: Air, which is available on the locomotive, is used as the power for closing contacts or switches which, in turn, connect the power to the motors. The switches are controlled by means of circuits known as control circuits. The power for the control circuits is taken from an independent source, a storage battery being furnished for this purpose. The battery has a voltage of from 20 to 32 volts. The general arrangement of the control circuits is as follows: The battery power is connected to a piece of apparatus known as the master controller. This master controller is located adjacent to the air-brake valves and provides the means for connecting the battery current to a system of control wires which run from the master controller to the unit switches. The energizing of a control wire operates a small air valve allowing the air pressure to enter a cylinder, moving the piston, and thereby closing the switch. Storage batteries must be charged. Before proceeding with a description of the control apparatus we will discuss the two different types of battery circuits or arrangements which are used with the electro-pneumatic system and show how the recharging is accomplished.

In the direct-current locomotive, the charging is easily taken care of by connecting the battery on the ground side across a resistance in the circuit of the motor-driven compressor. A diagram of connections for battery charging with direct current operation is shown by Fig. 1. There are two batteries, each of which is connected to a double pole, double throw, knife switch. These switches are cross connected so that either battery can be charged or connected to the control circuits. It will be noted that the negative side of the compressor is connected to the coil of the relay *R*, known as the battery charging relay, and then to the battery charging resistance. When the governor closes and the compressor operates, the current flows through the relay coil to point *A* on the resistance, hence through the resistance to ground.

The current energizes the relay, causing the plunger

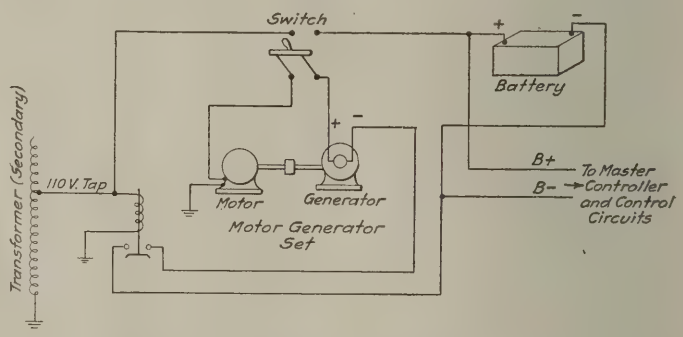


Fig 2—One Method for Charging the Control Battery on an Alternating Current Locomotive

to pull up connecting points *b* and *c*. With the switches open, as shown in Fig. 1, there is a voltage across the terminals + and — equal to the voltage between point *A* and ground. A current flowing through a resistance gives a voltage drop, and this voltage drop will depend on the position of *A*. That is, point *A* will be at a certain voltage and the voltage will be increased as *A* is moved further away from the ground end. A voltage can thus be obtained which is a suitable one for the type of battery used.

Two batteries are used each connected to a double throw switch at the hinge terminals. The other terminals are marked *B*+ and *B*— and connect to the control wires running to the master controller.

With both switches in the up position No. 1 battery would be furnishing power to the *B* + and *B*— for opera-

tion of the control, while No. 2 battery would be connected across the battery charging resistance whenever the compressor operated. With the switches in the down position No. 1 battery would be connected across the resistance, receiving the charging current, while the No. 2 battery would be supplying the power for the operation of the control. With two batteries it is possible to charge one battery while using the other, and by throwing the switches up and down on alternate days, the batteries are kept in first-class condition.

The arrangement as per Fig. 1 is not possible with the batteries on alternating current locomotives, as the passage of alternating current through the batteries would not charge them. Another arrangement is necessary. A small motor generator set is used. It consists of a motor directly connected to a generator. The motor is of the alternating current type, and is connected to one of the transformer taps of suitable voltage. The generator is of the direct current type wound to give a voltage suitable for charging the battery. While some a. c. locomotives have had two batteries interconnected so that one is used on alternate days, it is only necessary to use one battery. The arrangement is shown in Fig. 2.

A tap is taken from the transformer at approximately 110 volts, and is connected through a line relay to ground. The tap is also connected to one side of a double pole single throw switch. When this switch is closed the 110 volts is connected to the motor of the motor generator set which will operate whenever power is "on" the transformer. The other side of the switch is connected in the generator circuit. The current from the generator will pass through the switch to the battery, through the battery to the line relay contacts, through these contacts and back to the generator. The object of this line relay is to prevent the battery feeding back into the generator, running the generator as a motor when the power is cut off from the transformer and the switch is left closed. The leads to the master controller are tapped on as shown. When operating the generator furnishes power to the battery and to the control in multiple. In other words, the battery is "floating" on the line. It is being charged whenever the power taken by the control circuits is less than that delivered by the generator. The generator supplies the power to the circuits whenever the motor-generator set is running, and the battery is only for emergency purposes to take care of extraordinary drafts or to supply current to the control when the set is not running.

In our next article we will take up the designs construction and operation of the pneumatic control.

RAILWAY ELECTRIFICATION IN FRANCE AND BELGIUM

By Robert E. Thayer

Special European Representative

Along with other matters of railroad construction in France and Belgium due to the devastation caused by the war, very serious consideration is being given to line electrification. In France this is particularly desirable on account of the increased cost of coal, and because of the fact there are in certain sections of the country large water supplies, which can very easily be used for the operation of hydro-electric plants.

Committees of railway men and engineers have been formed in both countries, and a committee of French railway engineers has already arrived in America to study the situation there.

Electrification in France

M. Claveille, Minister of Public Works and Transports of France, in a report made on the future development of French railways, states that it is highly important for France to make the most of its vast resources in water power for generating electricity, particularly at a time when its supplies of mineral combustibles are not going to be sufficient to meet the needs of its industries. With this end in view, he had an inventory made, at the end of 1916, of the available hydraulic power of the public water courses, and later reports were requested for each region, showing exactly the quantity of hydraulic energy which could be used by the public services, employing the most modern methods, without completely using up the energy of the watercourses. A particular study was to be made of the economical use of electricity for motive power on railroads, the kind of traffic, its density, the grade of the lines, and the difference in cost of each region being considered.

The Service of the Control of Railroads, in agreement with the technical services, is in charge of the studies to be made regarding the use of hydro-electricity on the railroads. Particularly attention is to be paid to the fair division of electric power between the public services and agricultural and industrial interests, and committees were formed made up of officers of the Government, manufacturers, etc.

The special committee appointed to draw up a program for the electrification of the principal railroads has pursued its studies with energy and by the end of March 1919, had been able to gather together much valuable data concerning the use of hydro-electricity. Its program proposes the electrification of 5,220 miles of lines as follows:

Paris-Orleans	1,926 miles out of a total of 4.839 miles
Paris, Lyons & Mediterranean	1.367 miles out of a total of 6,040 miles
Midi	1,926 miles out of a total of 2,524 miles

With the traffic of 1913 the kilowatt-hour consumption would have reached:

Paris-Orleans	280 millions kw-hr.
Paris, Lyons & Mediterranean	550 millions kw-hr.
Midi	330 millions kw-hr.
Total	1,600 millions kw-hr.

With the estimated traffic in the immediate future the consumption is estimated at:

Paris-Orleans	560 millions kw-hr.
Paris, Lyons & Mediterranean	1,100 millions kw-hr.
Midi	600 millions kw-hr.
Total	2,260 millions kw-hr.

In determining upon lines to be electrified, the Midi and the Paris-Orleans considered the relation of the cost of electric power as compared with the cost of power with steam locomotives, and the comparison showed that mountain lines with sufficient traffic should be among the first to be electrified. They also considered the location of the source of hydro-electric energy in relation to the lines, and the importance of this power to other industries.

On the Paris, Lyons & Mediterranean, however, the possibility has been considered of using electricity on lines of low grade where there is a heavy traffic, even before putting it on mountain lines where the traffic of these lines is very small.

The proposed sources of electric power are the following:

For the Paris-Orleans—The Upper Dordogne River and its branches.
For the Midi—The Pyrénées.
For the Paris, Lyons & Mediterranean—Certain waterfalls in the Central Plateau and in the Alps, and the enormous reservoir of energy formed by the great plants at present existing or going to be constructed in the region.

The probable cost is estimated as follows, based on prices before the war:

Paris-Orleans	$94,000,000
Paris, Lyons & Mediterranean	93,000,000
Midi	148,000,000
Total	$335,000,000

With the traffic of 1913, electrification would save 1,500,000 metric tons of coal, and in the near future the economy should not be less than 3,000,000 metric tons.

A special committee has been formed for the purpose of studying the use of electric energy. It at first obtained all the information possible from the principal electric companies, and it will use this as a basis for improving the present legislation, if necessary, in order to promote the development of the distribution of power. Members of the committee have already visited America to study conditions there. The committee has also had a general map made of France, showing the present plants and the lines for distribution of electric power.

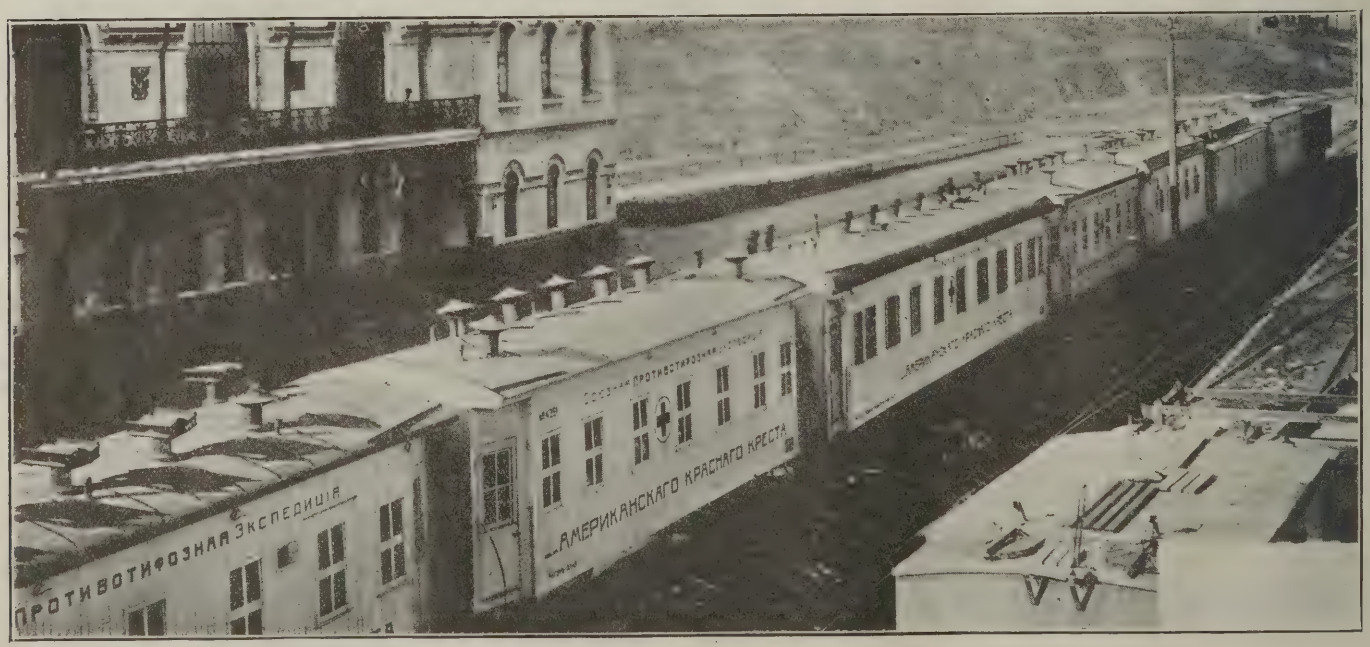
Electrification in Belgium

The plans for electrification on the Belgian State railways have not progressed to the same extent as on the French railways. An extensive commission has been formed, however, for consideration of the work. This commission is under the direction of Le Baron Ancoin, a member of the Belgian Senate, with M. Jacquin, who carries on the active work of the committee, as general secretary. He is located at 25 Rue de la Charité, Brussels. The commission has been divided into three sections, one considering the distribution of power, which is under the direction of M. de Loneux, Director General of electric power of Belgium, a second section to consider the rolling stock to be used, which is under the direction of M. Gerard, General Secretary of the Belgian State railways; and a third section on the management, which is under the direction of M. Tondelier, who is President of the Belgian State railways. Both English and French expert engineers are included in this commission; two of the members are, at the present time, in America with the French commission.

While no definite plans have been adopted, a direct current system, using the third rail with 1,500 volts, and a three phase alternating current system with 50 cycles, is being considered.

The plan under consideration now is to electrify important lines radiating from Brussels. The first line to be considered will probably be that between Antwerp and Arlon, a distance of about 147 miles. Consideration is also being given to electrification of the line from Brussels to Louvain, a distance of about 18.5 miles; from Brussels to Charleroi, a distance of about 35 miles; from Brussels to Braine-le-Compte, a distance of about 18.5 miles; from Brussels to Enghien, a distance of about 18.5 miles; and from Brussels to Ghent, a distance of about 36 miles.

Five Years Wandering in the Wilderness.—Pacific Electric box car 2586, which left the builders, American Car & Foundry Company, St. Louis, Mo., December, 1913, arrived on home rails (first appearance) May 18, 1919. It had made seventeen trips between the Middle West and Eastern States, three between Atlantic and Pacific ports, one trip between Colorado and Eastern states and two trips between Eastern states and Texas. On one road it stayed 108 days; another it visited nine times in one month. This is the last to arrive of ninety box cars bought in 1913.—*Pacific Electric Magazine.*



Photograph from American Red Cross

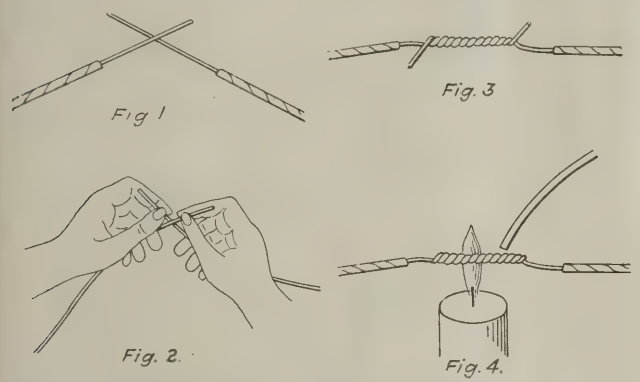
The American Red Cross Anti-Typhus Train

Thousands of persons in Siberia owe their lives to the treatment provided by this train. With a personnel of Red Cross doctors, nurses and attendants, its cars stocked with medical supplies of every sort, "The Great White Train," as it is now known throughout Siberia, has traveled back and forth across an area from Vladivostok to Chelyabinsk, 4,125 miles, caring for stricken soldiers and civilians and instructing communities along sanitary lines.

Various Types of Wire Joints and Connections

Size of Conductors and Kind of Service Determine the Proper Selection of the Splices

WIRE joints may be looked upon as a sort of necessary evil. Wherever it is reasonably possible to install a circuit without splicing the conductors, it should be done, for even when made with the greatest care a wire joint is rarely the equivalent of equal length of conductor. It is true that a joint can be made that may be all that could be desired when first put in service, but in time atmospheric and other conditions usually render the splice the weakest spot in the conductor, both mechanically and electrically. On aerial lines joints frequently become the seat of that most annoying trouble



Figs 1 to 4—Method Used in Making Joints in Small Wires

—intermittent open circuits. Where conductors are rubber covered and located in underground conduits, splices should never occur in the conduit itself. In such construction continuous lengths of the conductors should extend from one manhole to the next and the splice invariably made in the manhole. If this practice is disregarded and joints are made so that they lie in the conduit, it is almost inevitable that sooner or later the circuit will become grounded.

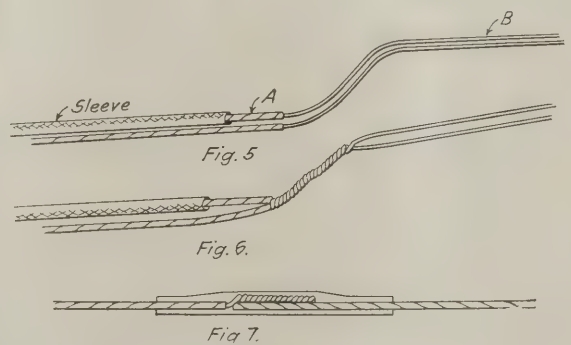
Unfortunately, there are many instances where it would be exceedingly expensive and therefore impractical to attempt to install circuits without splicing and for this reason the subject of making splices in the best possible manner should be given more consideration than it usually receives. Many men who are today masquerading under the title of electricians have only the vaguest sort of idea what the proper methods are for joining wires. It is not because the correct way of doing the work is so difficult to acquire, but rather on the contrary the matter is considered so simple that it does not receive the attention it deserves.

In the following paragraphs most of the commonly used wire joints are illustrated and described.

Joints in Small Wires

The term "small wires" is really a comparative one but what is referred to here is wire of No. 18 B. & S. gage or smaller. Because a wire is small does not mean that it is unimportant. Very often the most important circuits may be of conductors no larger than No. 22 B. & S., as this is the size commonly used in telephone cables. For the wiring of electric bells, annunciators and similar apparatus No. 18 B. & S. wire is frequently used and the manner of making a joint in wire of this size is illustrated in Figs. 1 to 4. The insulation, usually cotton, is removed for about two inches from the ends of the wires to be joined and the wires scraped clean and bright with the back of a knife blade. Next they should be crossed and held firmly between the thumbs and fingers as shown in Fig. 2, and given a twisting motion which results in the splice. Perfectly simple—and yet, the chances are ten to one that the first attempt will look quite different from Fig. 3. The secret in making this joint tight and uniform lies less in holding both wires absolutely rigid while the twisting operation is performed. If this joint is made from one inch to one and a half inches in length there is really no necessity for soldering it, as the contact between the two wires is made at so many points and so firmly that the danger of its opening is very remote. If, however, the wire is to be subjected to any pulling it may be better to solder the joint. This may be done readily by the heat of an ordinary candle flame and a piece of wire solder, a practice but little known or used except among telephone men.

Lead encased telephone cables are usually made in specified lengths to be installed at certain predetermined locations. Where such cables are used by the telephone companies the number of wires to be spliced at the end of each cable length may run as high as 1,200 for a single cable. Since each length of cable is roughly one block long, some idea may be had of the enormous number of wire joints required. In some instances railroad



Figs. 5 to 7—Sketch Showing Steps in Making a Splice in Telephone Cable Wires

companies have occasion to use similar lead covered cable but never to the same extent as the commercial telephone companies. In any case the necessity for making a good, serviceable wire joint is of prime importance and the method shown in Figs. 5, 6 and 7 is the one which has been found to meet all requirements. Where there are so many joints to be made, it is evident that speed in making them is a very important factor. Fig. 5 illustrates two conductors, one from each of the cables to be joined together. Before making the joint the cable splicer slips a piece of cotton sleeving, impregnated with paraffin, over one of the wire ends. The

wires are then placed together as in Fig. 5 and firmly held with the thumb and fingers of the left hand at the point *A*. The ends of the wires are tightly grasped at the point *B* with the right hand. The right hand is then rotated through a circle about the point *A* as a center, the point *B* traversing a path similar to the handle of a crank. The result is that the two wires twist together very tightly and form an excellent electrical connection. The excess wire is cut off, the splice folded back and the sleeve slipped in place as shown in Fig. 7. This joint is one of several hundred similar

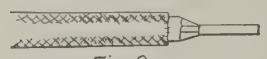


Fig. 8.

Fig. 9.

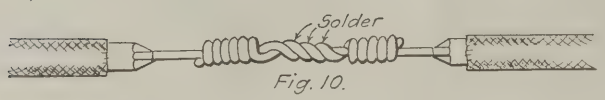


Fig. 10.

Fig. 8—Correct Way to Remove Rubber Insulation
Fig. 9—Incorrect Way
Fig. 10—Common Form of Wire Joint Extensively Used

ones to be finally encased in a lead sleeve, the ends of which are soldered to the lead cable sheath. The space not occupied by splices and wires in the lead sleeve is filled with a paraffin. It may be said, however, that this method of making splices could not be used with any satisfaction with wires larger than No. 18 B. & S.

From No. 18 to No. 6 B. & S.

In general as the size of the wire increases the uses to which it is put are such that something more than cotton insulation is required. Of course, there is one important exception to this, namely, bare wires in open line construction. However, where the insulation of wire is a necessity due to the grouping of a number of different circuits in a wire duct, rubber insulation is

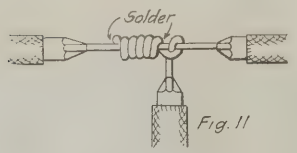


Fig. 11

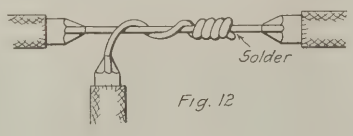


Fig. 12

Fig. 11—The Knotted Tap
Fig. 12—Tap Used When Flexibility is Desired

usually substituted for cotton when the wire is larger than No. 18 B. & S. The rubber coating is further protected by a heavy cotton braid. Wire of this description constitutes a very large percentage of interior wiring. It is used extensively where much electrical apparatus is housed in a relatively small space, such as on the back of switchboards. Signal departments use it in wiring relay cases and connecting circuits between signals, batteries and relays. The wire possesses such entirely different characteristics compared with the smaller cotton covered conductors, and the uses to which it is put are so different, the care given to such conductors likewise varies considerably from that received by the smaller wires.

In making a joint with rubber covered wire, the first step is to remove the insulation in the proper manner. Different wire manufacturers use various formulae in compounding their insulation covering, but all are designated as rubber insulated, although none of them consist wholly of pure rubber. Some of these rubber insulations part very readily from the wire which they cover, while others stick so tenaciously that the last trace of the insulation can only be removed by the diligent use of a knife blade or sand paper. Regardless of the kind of rubber insulation used, the wire should always be scraped clean and bright before any attempt is made to join it to another wire. In addition to the condition of the wire itself, the insulation should be cut away with a sharp knife in a manner similar to sharpening a pencil. The appearance of the wire when ready to be spliced is as shown in Fig. 8, except that the exposed portion of the wire should be three or four inches in length to facilitate manipulation. Insulation should not be removed as illustrated in Fig. 9, for the reason that a sharp knife is almost certain to nick the wire as indicated. This may not appear to be a serious matter, but experience has proved that a wire once nicked in this manner will inevitably break off at this point at some future time. This is particularly true with wires that are located in the vicinity of railroad tracks, where the vibration produced by passing trains aggravates the defective spot until a break occurs.

The most commonly used joint for wires larger than

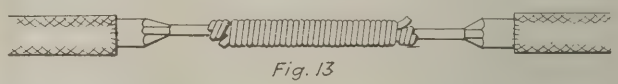


Fig. 13

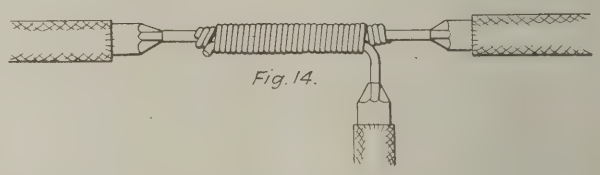


Fig. 14.

Figs. 13 and 14—One Form of Splice and Tap with Large Conductors

No. 18 B. & S. is shown in Fig. 10. The wires are crossed and a few twists are made similarly to those illustrated in Fig. 3. This part of the joint may usually be accomplished with the fingers. After this has been done, the ends are tightly wrapped around the straight wire for five or six turns. To do this properly it is generally necessary to use two pairs of pliers, one pair to hold the splice firmly while the second pair grips the loose end securely and tightly wraps each turn around the straight portion of the wire. The other end is then treated in the same manner. If the work is properly performed there should not be the slightest play in the joint. It should be perfect both mechanically and electrically without the application of any solder, but in order to keep it in this condition indefinitely, solder may be added to the twisted portion at the center.

One method of connecting a branch circuit to a main is shown in Fig. 11, which illustrates the *knotted* tap. The illustration is practically self-explanatory. By knotting the tap wire in this manner it is impossible for the two wires to become separated.

Another form of tap is shown in Fig. 12. This type is suitable for the smaller sizes of aerial conductors where a certain amount of flexibility is a necessity on account of the movement of the wires by the wind. Solder should be used as indicated in this sketch.

Splicing the Larger Wires

There is perhaps no hard and fast rule as to the size of wire which may be spliced in a given manner. It

is the facility with which the joint can be made which determines the method to be used. As a general thing, however, especially with hard drawn copper wire, it becomes quite a task to make a splice such as shown in Fig. 10 with No. 6 B. & S. wire and larger. It is not impossible, of course, as joints similar to Fig. 10 can be made in wire as large as No. 4-0, which is practically one-half inch in diameter. It should not be imagined, however, that such work can be accomplished with ordinary lineman's pliers, but it can be done with the aid of heavy wire cutters having handles several feet long. Usually when wires are as large as No. 4-0 the conductors consist of many strands of smaller wire and are spliced in quite a different manner, as will be shown later.

For joints in No. 6 B. & S. solid wire and other sizes that naturally require similar treatment, the method

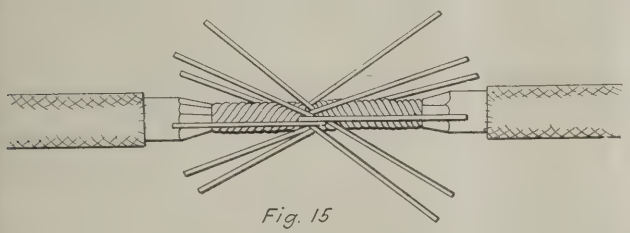


Fig. 15

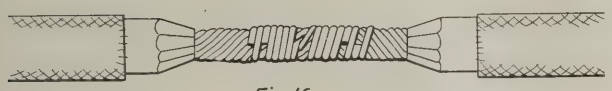


Fig. 16.

Figs. 15 and 16—Sketch Showing Manner of Splicing Stranded Conductors

shown in Fig. 13 will prove satisfactory. The ends of the conductors to be joined are prepared in the same manner as for other splices. The extreme ends of the bare wires are given a sharp bend backward and the surplus wire cut off. This results in short curved ends on the large conductors which prevent them from slipping out of the smaller binding wire while the joint is being made. Such a joint does not possess the tensile strength of one like Fig. 10 and should be well soldered throughout its entire length.

A tap connection, in which the same methods are used, is shown in Fig. 14.

Joints in Stranded Conductors

More often than not circuits using wire larger than No. 6 B. & S. are composed of stranded conductors. Not only do stranded conductors possess desirable flexibility, but they also present an entirely different problem in the matter of splicing. The various wires which enter into the composition of a stranded conductor are wound in concentric layers about the center. In order to make a joint in conductors of this sort, it is necessary to first cut away a large portion of the central core, after which the outer concentric layers are fanned out and the two cable ends butted together as shown in Fig. 15. The wires are interwoven in groups of two each and wrapped as tightly as possible along the cable, with the result shown in Fig. 16. Such a joint should be soldered and this can be most effectively done by pouring molten solder from a ladle upon and through the splice. The excess solder may be caught in a second ladle held underneath. Figs. 17 and 18 show the manner of making a tap with flexible wire. This joint should also be soldered in the same manner as the straight splice.

Patent Connections

The wire joints described in the foregoing paragraphs have been such as can be made with no other implements than the ordinary lineman's tools. In addition to these, however, there are numerous patented wire joints, some of them possessing much merit. In any case, the patented joint is not an absolute necessity and just as good a connection can be made with the simple tools and materials. The chief advantage of such joints lies in the fact that they can be disconnected and reconnected again very quickly if circumstances render such work necessary. For example, a ground occurring on a long underground conductor can be located much more easily if the conductor is joined at several manholes by connectors which can be easily and quickly taken apart. Once the conductor is separated, the trouble is easily located on one side or the other of the break.

Taping Wire Joints

Whether or not a wire joint is taped depends, of course, upon whether the line wire is bare or insulated. At one time, however, in certain sections of the country it was customary for telephone linemen to put rubber tape on joints in iron telephone wire. This practice is not followed today to any appreciable extent.

On the other hand, however, rubber insulated wire should be as effectively insulated at the joints as at any other part. This is accomplished by wrapping two layers of rubber tape over the joint. The tape should extend over the rubber insulation of the wire so as to make the insulation continuous. A double layer of friction tape should then be placed over the rubber tape. This friction tape should extend for at least an inch over the end of the braid covering of the wire. Further protection against moisture may be obtained by then painting the joint with some sort of asphaltum insulating varnish. This latter treatment may be omitted, but it

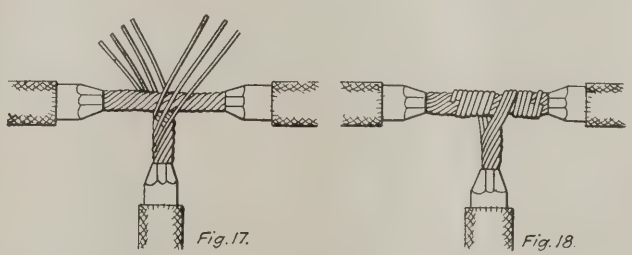


Fig. 17. Fig. 18.

Figs. 17 and 18—One Way of Making Tap With Stranded Conductors

is a good idea, especially if the splice is in an underground conductor located in a manhole.

For small wires such as No. 18 B. & S. gage, used largely for electric bells and similar apparatus, the insulation generally used is cotton. This is usually sufficient as such wires are seldom used on circuits exceeding ten volts. The insulation possesses very little dielectric strength but merely serves to keep the bare wires from touching each other. Joints made in such wire are satisfactorily insulated by simply using a small piece of friction tape.

Termination of Wires

The National Electric Code states that all stranded wires with conductivity greater than that of No. 8 B.

& S. gage must be soldered into lugs for terminal connections. Such a lug is shown in Fig. 19. With the smaller sizes of wire it is a simple matter to attach the lug. With large cables above one inch in diameter it requires more practice to make a good workmanlike connection. In either case the process is practically the same. The opening in the end of the lug is filled with solder and soldering flux, the lug being heated in the flame of a blow torch. Into this molten mass the end of the cable is repeatedly dipped until some of the solder adheres to the wires. This process, known as *tinning*,

Fig. 19.

Fig. 19—Terminal Lug and Cable End Prepared for Joining

is very essential to the successful connection of lug and cable. When the wires are well tinned the end of the cable is inserted into the lug up to the insulation and allowed to remain until the solder sets. If it is desired to expedite the cooling, which is rather slow, especially with big lugs, water soaked waste may be applied to heated metal and the work quickly completed.

If proper care was taken in removing the insulation and braid from the cable end, the finished work will show the insulation of the cable exactly meeting the end of the lug. Very often the insulation at the end is damaged by the intense heat to which the wires are subjected. In this case friction tape may be wrapped about the cable at the lug and a very creditable looking job obtained.

For smaller wires, particularly solid conductors, terminal lugs are not generally used. With a solid conductor a wire eye can be so neatly turned with a pair of pliers that any form of terminal lug would be superfluous. A wire eye correctly made is shown in Fig. 20. With a little practice it is an easy matter to make such wire eyes, absolutely circular in form, and with openings such that they will fit exactly over the binding posts they are intended for.

Fig. 20

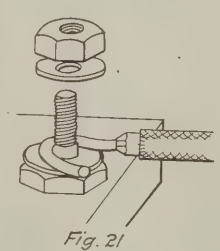


Fig. 21

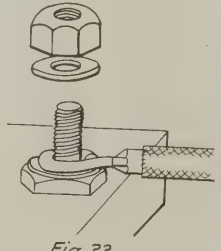


Fig. 22.

Fig. 20—Properly Constructed Wire Eye for Terminal Posts
Fig. 21—Incorrect Method of Applying Wire to Binding Post
Fig. 22—Correct Method of Applying Wire

It is when the wire eyes are placed on the binding posts that most of the trouble develops. If the eye is put on incorrectly the binding nut of the terminal post will tend to open the loop when it is screwed down. Subsequently the loop will open out as shown in Fig. 21 and eventually as the nut is turned tighter on future inspections, the wire will be squeezed out altogether. Note the difference in Fig. 22. In this case the loop is properly applied to the terminal stud. No amount of tightening of the nut will tend to open the loop, but on the contrary, the tendency will be for the wire eye to remain tightly closed. It is only a small matter, perhaps, but it is the knowledge of these little things that frequently makes a workman's reputation.

By no means all of the wire joints that are used have been described and illustrated in this article. There are others of more or less importance but the wireman who can make a neat workmanlike job of the splices and connections that have been shown here will have no difficulty in satisfactorily handling any wire joining problem he is likely to meet.

The Federal Board of Vocational Education has issued a 35-page pamphlet, for the benefit of disabled soldiers, sailors and marines, telling what kinds of work they may be able to find in the field of transportation, including steam railroads, street railways, wagons, automobiles and ocean steamships and harbor craft. The government stands ready to educate and re-educate disabled men, and the educational department in the military and naval hospitals will give inquirers all needed information. This pamphlet is designed to aid individuals in choosing a vocation. It tells what kind of work must be done, and what qualifications are required, in the case of telegraphers, train despatchers, station agents and other station workers, yardmasters, clerks, ticket examiners and traffic department employees; shop work, boiler making, blacksmithing, electrical work and car repairs; track work and train work. The work on electric railways and on ocean and harbor vessels is described in the same way. The Federal Board of Vocational Education, which is ready to give all possible aid to disabled soldiers, has offices in Boston, New York, Philadelphia, Pittsburgh, Baltimore, Washington, Atlanta, New Orleans, Dallas, St. Louis, Cincinnati, Chicago, Detroit, Kansas City, Minneapolis, Denver, and San Francisco.

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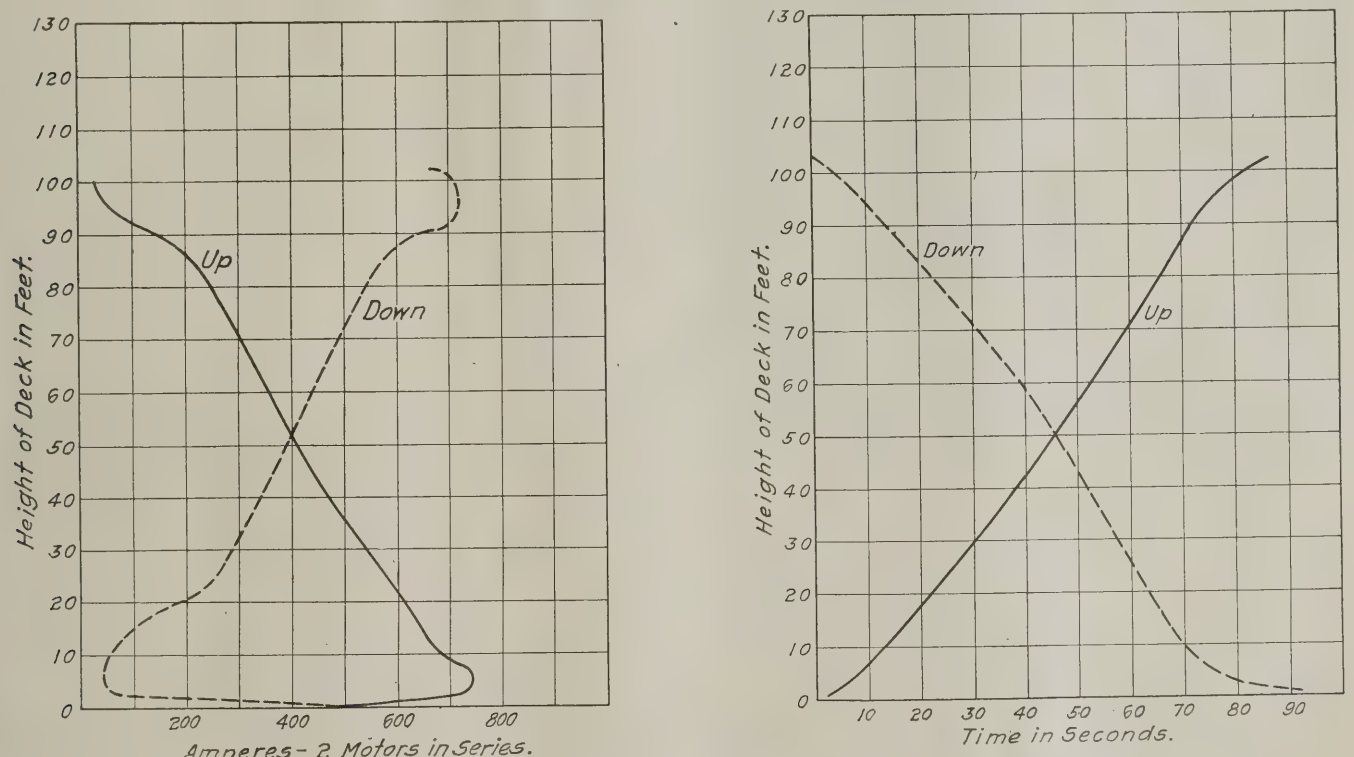
Scenes from Foreign Ports—A Train Load of Wool at Melbourne, Australia

Utilizing Electric Power at Movable Bridges

Its Adaptability is Shown in the Different Methods Applied in Operating Five Spans

By Mark H. Reasonu*

BEFORE choosing a type of motive power for the operation of movable bridges a number of factors should be considered, including the size and type of the bridge to be operated; the source of power; the dependability of the service; the method of application; the space and housing required for the apparatus; the ease with which the power can be interlocked to insure safety of railroad and navigation operation; the safety from the standpoint of operating the bridge and the cost of installation and operation. All of these factors have been met more or less fully in the many power-operated bridges now in service.



Curves Showing Current Consumption and Time for Raising the Span of a Lift Bridge

Electric Power for Operation

The use of electricity as the motive power for operating movable bridges involves the consideration of each of the factors mentioned, but, of all of the types of power available, the methods used in its application are the most flexible. This versatility is demonstrated in a group of five railway bridges recently built side by side over the Calumet river at South Chicago, Ill., on the main lines of the New York Central, the Pennsylvania and the Baltimore & Ohio. They each carry a heavy traffic which in itself is sufficient reason to warrant the provision of a source of operating power that assures safety, prevents delays and is subject to the minimum number of interruptions.

Electric power was chosen for the operation of each of these bridges because it was felt that the requirements could best be met by its use. In view of this fact it is interesting to note the methods of application adopted by these three roads. Two of the bridges depend solely on storage batteries charged by central station power while one is operated directly from central station lines, with a gasoline engine for emergency use. The remaining two bridges can be operated directly from central station service through a motor generator set; from a generator driven by a gas engine, or from a storage battery which can be charged from either source. Energy for the operation of all of the bridges is supplied from a substation of the local power company in South Chicago, a few blocks away. A 4,400-volt, 3 phase 60-cycle circuit is carried on a pole line from the substation to the west bank of the river. The substation is supplied with power from the main distribution system by means of 3 sets of underground circuits.

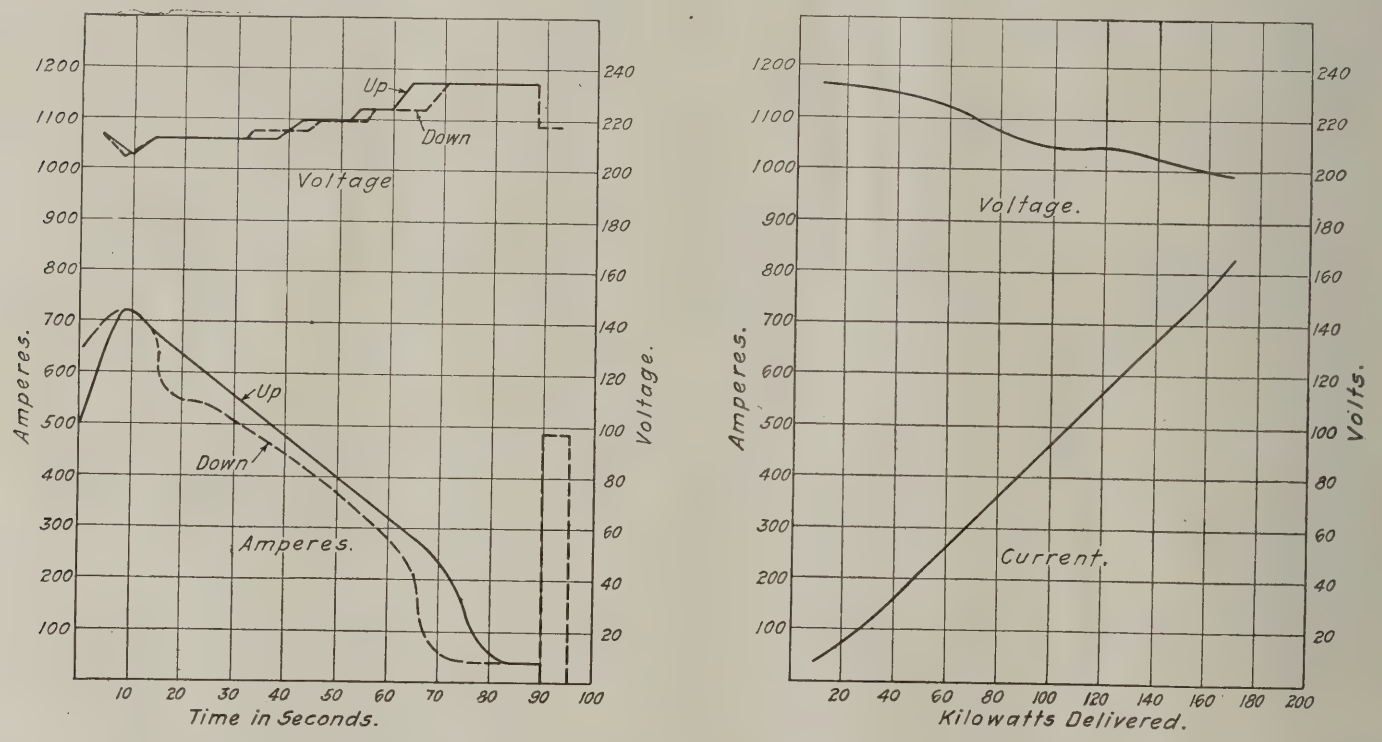
The Baltimore & Ohio Bascule Bridge

The Baltimore & Ohio bridge is a Strauss bascule span of the cantilever type, 246 ft. long, the longest single span bridge of this type in the world. The power service lines connect to a transformer vault on

*Works manager, Diamond Chain & Manufacturing Company, Indianapolis, Indiana.

the west bank of the river, from which side the bridge is operated. Three transformers of 100 kw. capacity each step the voltage down to 440 volts, which is the operating voltage.

In order to raise the cantilever span the switches must be closed in a predetermined order, that is an interlocking system prevents the transmission of energy to the motors in case of carelessness or mistake on the part of the operator. After the switches which control the front and tail rail-locks have been closed, a bridge-lock switch is closed, thus releasing the structure for raising at the same time an automatic circuit-closer, which connects the two bridge motors to the power line, is closed. These motors are of the induction type and of 140 h. p. capacity. The speed is governed by drum-type controllers. The general practice is to use both motors in operating the bridge, so as not to throw a large load on either when starting. Each motor, however, has sufficient capacity to operate the bridge, assuring satisfactory operation if one of the motors should be out of commission. If both motors are disabled or if the electric power service fails, a 35 hp. gasoline engine is used for the operation of the bridge. It is connected with the chain of drive gears by means of a sliding gear by which the motors are automatically disconnected when shifted for gasoline engine operation. During the summer months when navigation is at its height, the bridge is raised and lowered on an average of about 30 times daily, while during the navigable winter months this average is reduced to 4 times. It requires about 1.5 min. to raise and lower the bridge.



Curves Showing Power Relation and Current and Voltage for Raising and Lowering the Span of a Lift Bridge

The New York Central Bridges

A short distance south of the Baltimore & Ohio bridge are two double track vertical lift bridges of the New York Central. The spans are 206 ft. long and weigh about 900 tons each. The electrical installation for the operation of these bridges is more elaborate than that installed on bridges of either of the other railways. Three sources of electric power are provided. Central station service connected to a motor generator set, from which the bridge may be operated directly; a gasoline engine direct connected to a generator, which will supply energy for bridge operation, and a storage battery system, which may be charged from either generator, and which is generally used for supplying the energy for operating the bridge. These interconnected systems are independent of each other except in the extreme case when the batteries are discharged.

The central station company's service of 4,400-volt, 3-phase, 60-cycle on the west bank of the river is carried in a 3-in. iron pipe through a tunnel underneath the river to the transformer vault on the east bank where the railroad's power plant is located. From the transformers a 440-volt secondary circuit connects to the main switchboard, then through meters to the control switch of a 175-h. p. induction motor direct-connected to a 220-volt d.c. generator. Switchboard equipment is also provided in order that the output of this generator may be used to charge the storage batteries or may be directly connected to the bridge motors.

The gasoline engine unit consists of a 200 hp. four-cylinder Bruce-Macbeth engine direct-connected to a 175 hp. generator similar to the one forming part of the motor generator set, and which also has switchboard equipment for supplying power to the batteries or to the bridge motors direct. Apparatus is also provided for running the generator as a motor from the storage battery for starting the gasoline engine. The motor generator set is used in general for charging the storage batteries of 117 cells, which have a total

capacity of 2,600 ampere-hours. Most of these cells are for bridge operation although a portion provide energy for signaling equipment.

Each bridge is operated by two 100 hp. mill-type series motors, which drive a train of gears connected to drums for winding or unwinding the cables which raise and lower the lift span. On lowering, the motors drive through a load brake in a manner similar to that on the hoist of an electric crane. The lift span is supported on the four corners by cables and sheaves suspended from the end towers, the weight of the span being kept uniform by means of heavy equalizer chains attached to the towers and the lift span. The motors of both bridges are operated by control apparatus located in a stationary tower between the two bridges. The control is semi-automatic, consisting of two three-point hand controllers with relay-operated switches for changing the grid resistance in the supply circuit. Precautionary methods are provided for the safe operation of the bridges. Bridge and rail lock switches must first be operated before energy can be supplied to the motors. To further guard against accidents, the electrical system is arranged so that either bridge cannot be unlocked for raising until the signals are operated to indicate to the engineman of an approaching train that the bridge is open for river traffic. In this connection derails are also used to provide against the possibility of an engineman running by a stop signal.

During the summer months each bridge is operated 20 to 25 times a day. They can be raised to a maximum of 98 ft. in about 45 sec. with a power consumption of about 5 kw. hrs. When navigation is open the total energy used per month for charging the batteries for bridge and signal operation approximates 7,000 kw. hrs. with a maximum demand of 140 kw. hrs. The storage battery system permits the use of service during off peak periods, making the load desirable from a central station standpoint.

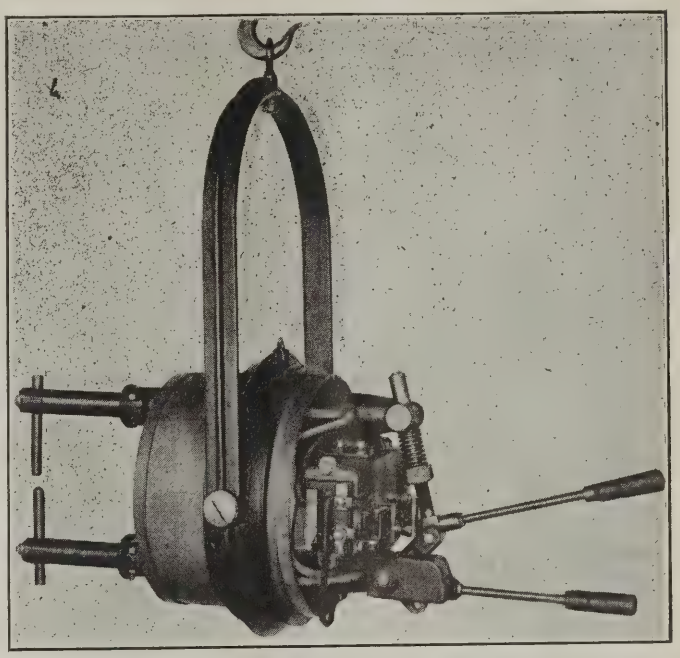
The Pennsylvania Bridges

Adjacent to the New York Central bridges are two double track bridges of the same type on the Pennsylvania. Each lift span is 210 ft. from center to center of end pins, and the total weight of each is about 950 tons. The method of operation of the lift spans is similar to that of the New York Central structures except that the operator's tower and control equipment are a part of each lift span and travel with it. Central station service is supplied to two motor-generator sets, each consisting of a 35 h. p. induction motor connected to a 220-volt d. c. generator. Ordinarily one of the sets is used for charging a storage battery system, the other set being provided for emergencies. This equipment, together with switchboard, etc., is installed in a concrete cellar underneath the tracks on the west bank of the river. The storage battery equipment is depended upon entirely for the operation of the bridges, and has given satisfactory and uninterrupted service. The power consumption, which is off-peak, is about 5,000 kw. hrs. a month for 20 to 35 lifts a day.

The accompanying diagrams show the operation characteristics of the electrical equipment of a lift bridge of the type described.

PORTABLE SPOT WELDING MACHINE

A number of portable spot welding machines are being made by the Universal Electric Welding Company, 30 East Forty-second street, New York. One of the smaller machines is shown in the illustration. This machine has a rating of 40 kw., with a 50 per cent overload capacity. It can be used for welding material up to ¼ in. in thickness. It can be rotated in a horizontal and vertical plane and used in any position. The handles, electrodes and all parts clear the supporting sling. The arms which hold the electrodes can be slid in and out of their clamps and can also be rotated so



Welding Machine Suspended from the Hook of a Chain Hoist

that the electrodes will engage others at any desired angle. The arms are water cooled.

The welding operation is a simple one. As the handles are brought together the electrodes engage the material to be welded. When the pressure has been increased to a certain value the current is turned on automatically and is turned off automatically just before the maximum pressure is reached. Plates ⅛ in. in thickness may be welded with this machine in three seconds.

A 10-point switch in connection with a reactance makes it possible to obtain 100 different values of welding current. The maximum opening between the electrodes is about 12 in. and the machine complete weighs 400 lb.

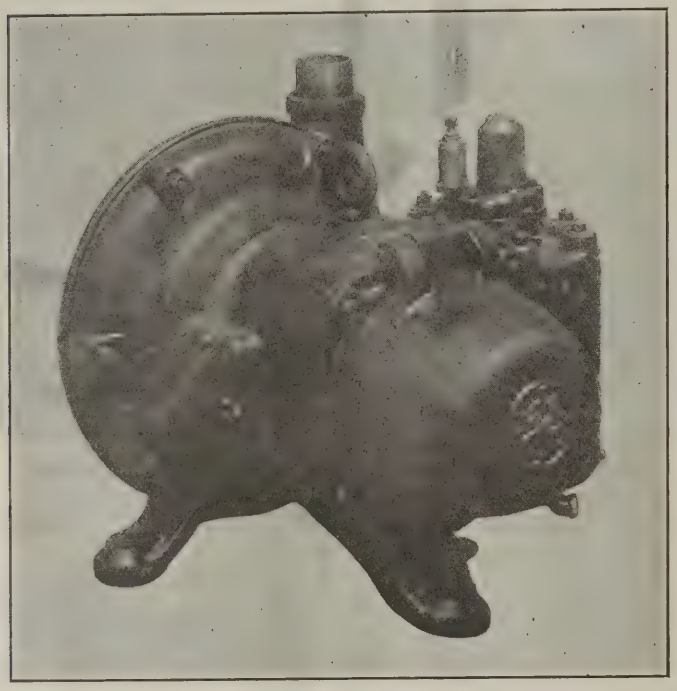
Similar machines are built for welding metal up to one inch in thickness. In the case of the larger machines, air or water cylinders are used to obtain the required pressure between electrodes.

Electric Fans in India.—In Calcutta the Electric Supply Corporation has connected to its system more than 44,000 fans, 37,000 lights, and more than 1,200 motors. The superiority of electric fans to the punkah-wallahs—coolies who work fans by hand—is being steadily appreciated. The municipal committee of Simla, the summer capital of India, is considering an extension of the existing electric plant there.

TURBINE HEADLIGHT SET FOR STEAM LOCOMOTIVES

To meet the requirements of steam locomotive headlight service, the General Electric Company, Schenectady, N. Y., has placed on the market a turbine generator set known as type CY-32B, especially designed to supply power for the headlight and cab lights. This set consists of a single stage Curtis turbine direct-connected to a compound wound generator governed on the steam end by a self-contained pressure regulating valve, and controlled electrically by a stationary magnetic brake coil and rotating copper disk which maintains practically constant voltage under different loads.

The machine is made in two sizes, 175 watt, 6½ volt, and 500 watt, 33 volt, for operation on boiler pressure varying between 125 and 225 lb. per sq. in. It is composed essentially of one metal casting equipped with three substantial feet. This casting embodies the generator



The General Electric Company's CY-32B Turbine Headlight Set

frame, regulating brake coil chamber and turbine casting. The generator and shield carries one of the ball bearings and the brush holders, and the exhaust head carries the other ball bearing.

The rotating part is composed of a shaft upon which is mounted the armature and bucket wheel and to the bucket wheel is riveted a copper disk by means of which the load regulation is obtained. Cast integral with the main frame is a steam separator upon which is mounted the pressure reducing valve and pop relief valve.

The steam pressure at the turbine is maintained constant by the action of a hollow valve stem working against the pressure of a spring, the section of the stem immediately below the ports being tapered. The tension of the spring is adjusted by the addition of thin washers so that when the boiler pressure does not exceed 125 lb. the stem remains in its lowest position and no throttling of the steam takes place. When the boiler pressure exceeds 125 lb. the stem is forced up and the tapered portion throttles the steam flowing out. The upward movement of this stem at all boiler pressures above 125 lb. is just sufficient to maintain constant steam pressure at ports in the valve bushing.

The magnetic brake has no moving parts except the copper disk which is riveted to the bucket wheel and rotates in the air gap around the pole faces. The brake winding consists of a series and a shunt coil so proportioned that at full load the series coil neutralizes the magnetic effect of the shunt coil. Consequently no drag is produced on the rotating copper disk. When either the headlight or cab lamps are turned off, thereby reducing the current through the series winding, the field set up by the shunt winding is not entirely neutralized by the series field and produces eddy currents in the copper disk which results in a sufficient drag to hold down the speed of the rotor, thereby preventing over voltage. The machine will run at its highest speed, 3,600 r. p. m. at full load and any other condition produces a lower speed, unless an open circuit occurs between the brushes and brake windings. In this case, of course, no voltage is generated and the speed increases to approximately 5,000 r. p. m., a speed which the machine is made to withstand, however.

The braking effect prevents the burning out of the generator coils, for if an overload or short circuit occurs, the flux from the series coil overbalances the flux of the shunt coil, thereby producing a drag on the copper disk which is proportional to the amount of the overload. While the full-speed current of the machine is 15.2 amperes, and the speed 3,600 r. p. m., the short circuit current is about 12.8 amperes and the short circuit speed approximately 800 r. p. m. This form of governing is, therefore, not only simple, but it is also of value as a protection against burned-out windings. There are no moving regulator parts to become worn.

Railroad standards have been followed in the mechanical design. Only two sizes of cap screws and one size of nut are used, both sizes of cap screws being hex headed and slotted, so that if necessary the machine can be completely disassembled with the aid of an ordinary wrench and screwdriver.

Electrification in Italy.—Recent electrification of a railway stretch in our Northwest attracted much attention but it will look small beside the Italian project—the electrification of 4,000 miles by use of Trentino waterfalls. In two of Italy's greatest manufacturing cities, Milan and Turin, there is already extensive use of water power. The available horsepower was in 1914 less than Austria-Hungary's, but territorial acquisitions have changed the balance, and Italy should now be able to develop more hydro-electric energy than any other European nation save Norway and Sweden. Even before the war she utilized more water than any other country except France and Norway. Italy was then importing nearly $40,000,000 worth of coal a year from Britain, and her chief complaint has ever since been that she could not get enough. To dig coal in England and laboriously transport it to the Po Valley while river energy there runs unused to sea typifies a kind of waste of which the world will hereafter be more impatient.—*New York Evening Post.*

PRACTICAL STUNTS

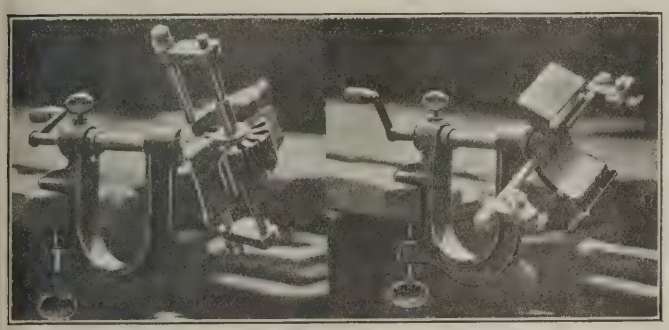
Handy Device for Winding Small Armatures

By James Majosky,

Electrician 47th St. Shop.

Chicago, Rock Island & Pacific, Chicago.

The illustration shows a new armature winder which is being used at the Chicago, Rock Island & Pacific shops, 47th St., Chicago, for winding small armatures of electric fans and Consolidated type "A" regulator motors. Practically the entire device was made from odds and ends picked up around the electrical shop. The



The Armature Winding Machine

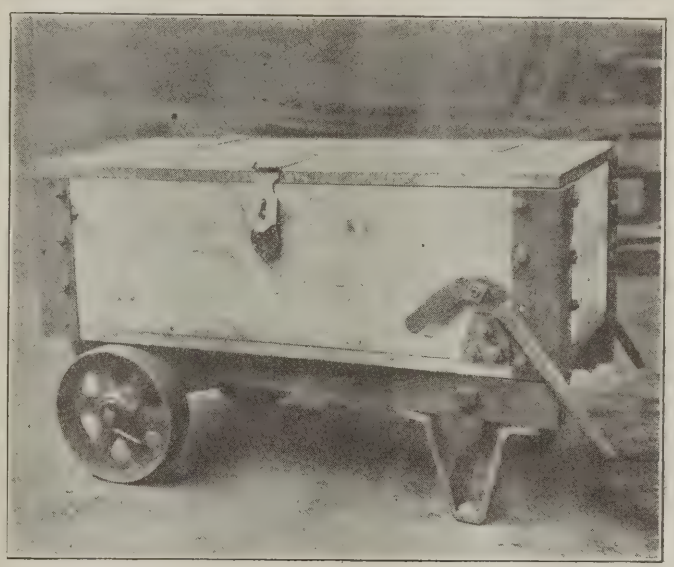
illustration shows the device fitted with and without an armature. By means of this instrument armatures are now being wound in from 10 to 20 min., while formerly it took from 2 to 3 hours to accomplish the same task. Besides being a time saver, it will do the job in a much neater manner; the wire will lay smoother and will take up less space than seems to be the case with armatures wound by the old method. This armature winding machine has proved so successful that plans are now underway for providing an extension in order to be able to insert armatures of a much larger size.

Electrician's Tool Box

The work done by the great majority of shop electricians necessitates their moving a number of tools from one part of the shop to another. Usually, the man carries the tools he thinks he is going to need to the place he is working and almost always he finds it necessary to go back to the tool box for other tools. An ordinary hand truck frequently solves this difficulty but there is not one always available when wanted.

The illustration shows an electrician's tool box bolted to a hand truck frame. It was found that the truck handles were very much in the way when the electrician was working around the box, so they were sawed off and drop handles as shown were made in the blacksmith shop and applied to the box. The handles may be raised to a horizontal position before the stop engages and the end of the box is lifted.

Such boxes are quite common in new and rebuilt shops where cranes have made many hand trucks obso-

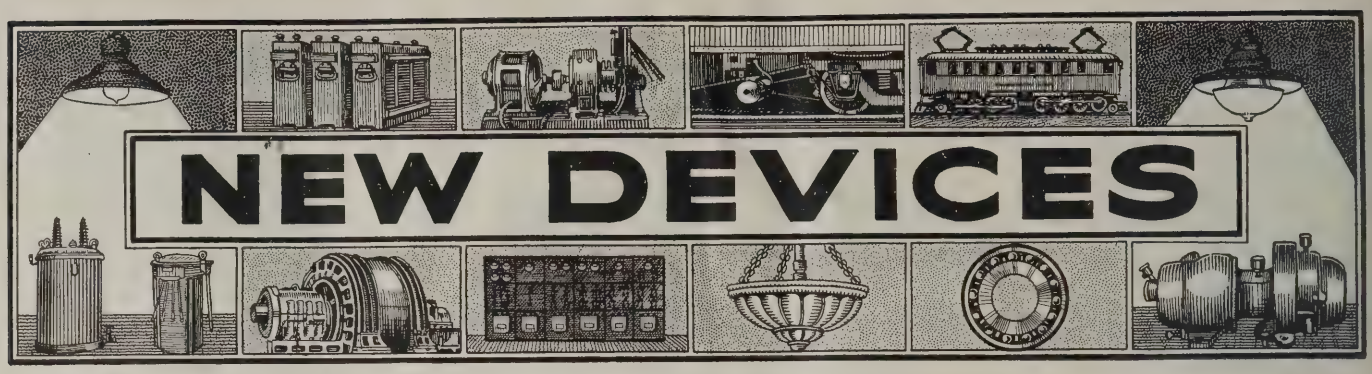


Tool Box Mounted on Truck for Use in Large Shop

lete. An old hand truck is otherwise not often available for such a purpose. However a hand truck is not the only way in which a tool box can be equipped with handles and a pair of wheels, and the illustration is offered as a suggestion.

Fluxes For Soldering

It is not an unusual thing to encounter a great deal of difficulty in soldering iron or steel parts. Unless the right flux is used the process of "tinning" a piece of iron is very tiresome. The trouble may be overcome however by using a flux composed of ten parts of borax and one part of sal ammoniac. If iron is already coated with tin, resin or chloride of zinc will suffice. Copper and brass may be easily soldered by using a flux of sal ammoniac or chloride of zinc. Resin or tallow may be used successfully on lead, while for lead and composition pipes, resin and sweet oil gives good results. Zinc can be readily soldered by using chloride of zinc.



A New Improved Hydrometer

In using hydrometers considerable trouble is often found in obtaining accurate readings due to the tendency of the hydrometer float to adhere to the sides of the glass tube containing the liquid. A new hydrometer, known as the Everett Railroad Signal & Service Station Hydrometer No. 21, which is being marketed by Edward A. Everett, New York, overcomes this troublesome sticking. As may be seen in the illustration the hydrometer float is equipped at top and bottom with glass pin points which prevent the float from sticking to the inner sides of the containing tube. A rubber stopper at top and bottom, together with the pin points protect the float from liability to breakage.

The New Hydrometer

The hydrometer has a long stem and specific gravity scale which provides for close reading for storage battery work. In general the apparatus is well made, and accurate, and is intended for service. The length over all is 18 in.

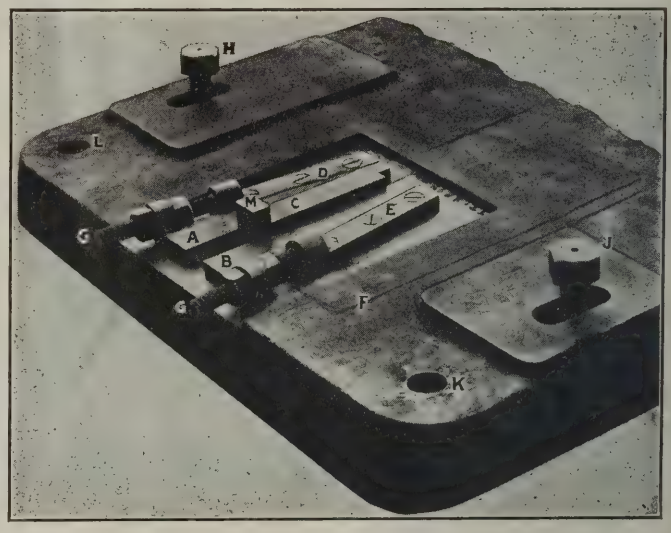
The elimination of the sticking of the float will make it possible to test the specific gravity of many cells in a short time.

Adjustable Anchorage for Motors

A device designed to insure accurate alinement and permanent anchorage for electric motors is being marketed by the Adjustable Anchorage Company, 1502 Ford building, Detroit, Mich. This anchorage permits a limited adjustment of the motor in all directions and may be used on either direct connected or belt-driven motors.

A half-view of a bed plate with the anchorage applied is shown in the illustration. The motor is set on the bed plate with keys *C* set tightly in slots in the bottom of the motor at both ends, the lugs *M* pressing against the motor base. To rotate or move the motor to either side, the bed plate bolts *H* and *J* are loosened and the wedges *A* and *B* moved alternately in or out by means of the screws *G*. The wedges bear on the surface of the guides *D* and *E*, the taper of the wedges thus moving the keys laterally, which in their turn move the motor with them.

This anchorage, by providing universal adjustment of the motor in a horizontal plane, makes possible an accurate alinement, which once obtained is permanently held by the key *C*. This is of particular value in the adjustment of magnetic clutches and in the perfect alinement



Arrangement of Adjustable Anchorage for Motors

of the shaft, which eliminates eccentric movement and thus prolongs the life of the journal bearings.

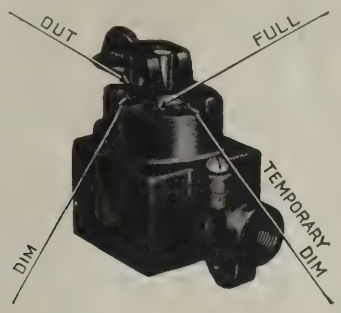
To tighten or loosen a chain or belt the key *C* is loosened by drawing out the wedges slightly and moving the motor by means of a screw set in a lug cast on or a stud tapped in the bed plate at *F*. This device may be installed on old motors or on new work.

New Locomotive Headlight Switch

A new locomotive headlight switch has recently been put on the market by the Crouse-Hinds Company, Syracuse, N. Y. It is a self-contained, dust-tight switch that will effectively perform the duties of a double-throw knife switch for shifting from dim to full light, and a momentary contact switch for temporary dim light.

With an easy push the handle goes from the "off" to the "dim" position and another slight push sends it to "full" position. While passing another locomotive or when picking up signals it is not necessary to bring the switch back to the "permanent dim" position. The engineer merely pushes the handle from "full" to "temporary dim," holding it until he has passed the other train or the signals, after which he releases the handle and the switch automatically snaps back to "full" posi-

tion. If going through a yard or a city where the headlights must be dimmed, a slight shift of the handle

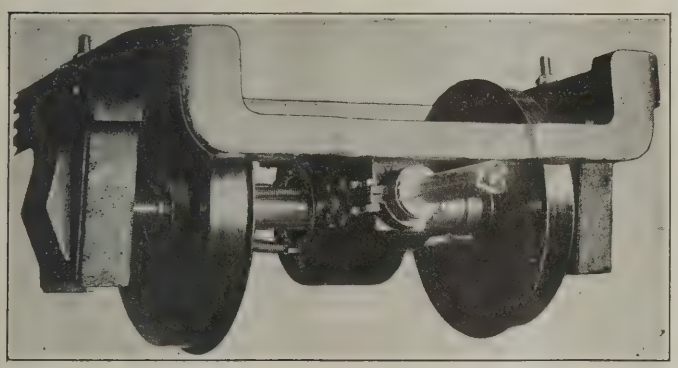


Four Position Locomotive Headlight Switch

brings the switch back to the "permanent dim" position.

Shaft, Gear and Spring Drive for Axle Generators

The Safety Car Heating & Lighting Co., New York, has developed a new method of drive for car lighting generators, using a principle entirely new and unique in its application. Power is transmitted from the revolving car axle through springs connected to gear mechanism mounted on the truck, but free from the axle. Two split collars are bolted to the axle between the wheels, one at each end. Attached to each of these collars are three coil springs paralleling the axle and connected to the split drum. This drum surrounds the axle about midway between the wheels, but is of such internal diameter as to give several inches clearance between the axle and



Driving Mechanism Mounted on Axle

the drum. A flexible shaft running at right angles to the axle is geared at one end to the drum and at the other end to the armature shaft of the generator, the generator being mounted on the car body. The drum and gears are mounted in a two-part housing, split horizontally and bolted together; the upper part is securely fastened to the truck frame.

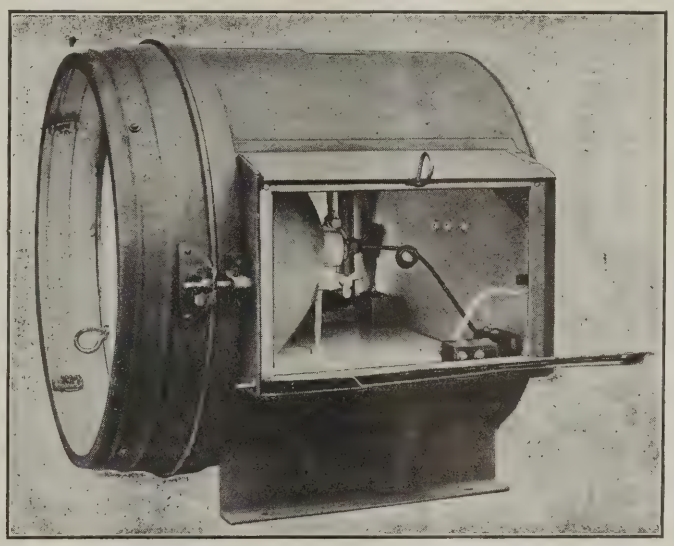
The generator being mounted in a fixed position on the car and connected to the axle drive by a shaft, necessitates providing for the variable relations between the car body and the axle when the car is traveling on a curved track. Compensation must also be made for side thrust through the truck equalizer springs and the variable pressure on the bolster springs. This is accomplished through the springs connecting the car axle with the geared drum. These springs not only give great flexibility in operation, but also provide wide latitude in assembling at the shops or on the road.

In case of flat wheels or other defects to wheels or axle, provision is made for quickly changing wheels and axle without changing any parts of the generator drive, thereby avoiding the necessity of carrying extra parts with each new axle. The same equipment can be applied to either straight or tapered axle without change, which is, of course, a great advantage.

The device is simple and compact and devoid of intricacies which the operator and inspector usually condemn.

Electric Headlight and Generator

The Schroeder Headlight & Generator Company, Evansville, Ind., has improved its equipment by the addition of several devices. Automatic disconnecting switches have been applied to the headlight so that the reflector and other internal parts in the headlight case may be removed without the necessity of disconnecting



Headlight with Side Open, Showing Disconnecting Switches

any wires. Another improvement in the headlight makes the interior of the headlight easily removable and at the same time holds it firmly in position under all conditions of vibration to which headlights are subjected.

A piston valve, operated by the governor which controls the flow of steam and the speed of the turbine, has been added. The makers claim that this valve has done away entirely with the sticking of the valve caused by deposits of lime or other foreign substances common to localities where the water is bad.

Mazda Lamp With Milk White Bulb

A Mazda lamp of a new type has just been placed on the market by the Edison Lamp Works of the General Electric Company, Harrison, New Jersey. The new product which is designated as "C-4" is similar in every way to the larger Mazda "C" lamps except that it has a tipless bulb of milk-white glass. The bulb is 2½ in. in diameter and 5⅛ in. long over all. The lamp is made for the 110 to 125 volt range.

General News Section

Weston Electrical Instrumental Co., 4 Weston Avenue, Newark, N. J., has had plans prepared for the erection of a new addition to its plant. The structure is estimated to cost $7,500.

The Telegraph Companies of the United States, according to a report from the Bureau of Census, covering data gathered in 1917, operate 241,012 miles of pole line, comprising 1,888,793 miles of wire. They sent 151,725,228 messages and employed 47,227 persons.

The United States Fuel Administration recently published a technical paper, No. 217, on "Saving Coal in Steam Power Plants." Only a limited supply is available for free distribution. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C., giving the number and title of the paper.

The Edison Storage Battery Co. announces the removal of its district office in Pittsburgh, Pa., to Room 431 Union Arcade building. The removal has been made necessary by the tremendous increase in the volume of business handled through this office. The new location provides better facilities and more commodious quarters.

An Intoxicated Man boarded a locomotive in the Baltimore & Ohio yards at Pittsburgh, Pa., on June 28 and opened the throttle. The engine headed out on one of the lead tracks where it collided with another engine, doing considerable damage. The man was arrested and later sentenced to a term of 90 days in the county workhouse.

Westinghouse Electric International Company, 165 Broadway, New York City, is the new name for the Westinghouse Electric Export Company. Maurice Coster, formerly managing director for the company, has been elected vice-president of the new organization, and will be in charge of the company's commercial business with the same duties as he has heretofore exercised.

"Two Popular Methods of Getting Killed," is the title of the latest safety-first pamphlet issued by George Bradshaw, safety supervisor of the Pere Marquette and other Michigan roads under Federal Manager F. H. Alfred. The two methods are the highway crossing method, and walking along railroad tracks. Interesting comparisons are drawn between these American methods of getting killed and ancient methods of accomplishing the same purpose; and the ancients are believed to have had the better way.

The Air Mail Service between New York and Washington is reported as having been operated during the month of June at 90 per cent efficiency; the miles flown being 11,118, and the weight of mail carried, 15,643 lb. Between Cleveland and Chicago the percentage of efficiency is given as 100; total miles 19,825; weight of mail 19,603 lb. The average speed on this route was 97.8 miles an hour. The route from New York to Cleveland, crossing the Allegheny Mountains, has been operating successfully since July 1.

Losses of Gasoline during transit, are estimated by one prominent producer and shipper of gasoline to amount to eight per cent, considering only that shipped in tank cars. During 1918, about 3,500,000,000 gallons of gasoline were produced in the United States and much of it was shipped more than once. A loss of one per cent, at 20 cents a gallon, means a loss to the shippers and to the nation of $7,000,000. The railroad loss and damage figures recently published, are large, but the shippers' probable wastage through leakage and evaporation during transit is larger.

The Electrification of French Railways.—M. Cels, under-secretary for public works and transports, stated recently that he will introduce in the French Chamber a bill for the utilization of water power in France by absorbing all private undertakings into one combination. The greater part of the power thus obtained will be allotted for the electrification of the main railway systems of France. The electrification of the Midi has already been begun, the water power of the Pyrenees being brought into use. For the Paris-Lyons-Mediterranean Railway, the power will be found in the Alps. The bill has also in view the improvement of lighting, tramway traction, and a system of pumping for feeding agricultural irrigation and local industries.

Thousands of returned soldiers are being put back in their former positions on the Baltimore & Ohio, the Western Maryland, Pennsylvania and other railroads, according to a press despatch from Cumberland, Md. This is one result of the tremendous exodus of foreign railroad men and laborers to their own countries. Foreigners who are said to have moved in large numbers from West Virginia, when that State went "dry," to Pennsylvania and to Maryland have been leaving this country at a high rate for the past month, anticipating country-wide prohibition. They expect to secure lucrative work in their native lands and also have alcoholic stimulants. Six new coal mines have been opened or have resumed work on the Cumberland division of the Baltimore & Ohio, since June 15, increasing the demand for trainmen.

Air Mail Declared a Success—Rate Reduced

The postmaster general has fixed the rate of postage on mail carried by aeroplane at two cents an ounce, the regular postage rate for first-class matter, placing the air mail service on the same footing as other means of transportation. He says that the experiments of the past year have demonstrated possibilities beyond expectations. By the use of the Liberty engines now available from the War Department, 10,000 letters a day for San Francisco and other points on the Pacific Coast which fail to con-

nect with the westbound 8:40 p. m. train out of New York are being advanced 24 hours daily to their points of destination. Mail from New York that did not catch the 5:15 p. m. train for the West is now being delivered in Chicago in the afternoon instead of the second morning. Arrangements are being made to place on the New York-Washington route the three fastest aeroplanes in the air mail service, each having a capacity of 18,000 letters and a maximum speed in calm weather of 132 miles an hour.

The following statement says, further: "The great saving of time now effected over the fastest railroad train between New York and Chicago will enable the department to make a saving in car space of more than twice the cost of the operation of an air mail service on that route."

Electrification Considered for Jamaica

The government of Jamaica is reported as arranging to have a survey made of the water power of the large rivers to see if electrification of the railways is feasible. The heavy cost of coal and the necessity of a considerable railroad extension owing to an expected agricultural development explain the proposed change. The local agent of the Westinghouse Company, of New York, is collecting data on which the Westinghouse might tender for laying down the electric railroads.

First Fall Meeting of the New York Car Lighting Club

The activities of the New York Car Lighting Club for the season of 1919-20 will commence with the first fall session on Tuesday, September 9, at 8 p. m. Although it is customary to hold the meetings on the first Tuesday of each month, on account of Labor Day immediately preceding this date it is believed that the second Tuesday in September would be more suitable for the opening meeting. The same room will be used for the meetings as heretofore—Room 1030 Grand Central Terminal. Let every member turn out and start off the program for the season in a live and energetic way. There's a lot of things about car lighting that you'd like to know and one of the best ways to find out is ask some of the other fellows about it.

Blockade By a Pint of Water

This is the heading in the New York *Sun* of an account of the stoppage of all trains to and from the Pennsylvania terminal, New York City, for about 30 minutes, on July 23, because of the failure of electric power. The mosquito, which once on a time stopped innumerable trains by getting caught between the points of a relay controlling a block signal, is outdone. The *Sun* says:

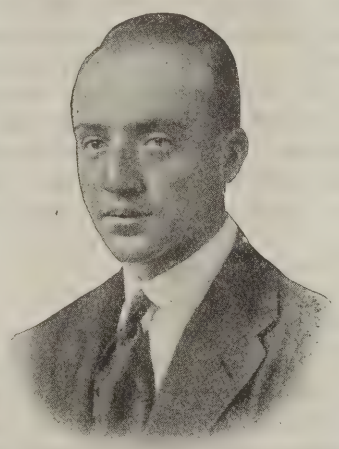
Rainwater, after eight days of gentle persistence, succeeded at 4:27 o'clock yesterday afternoon in seeping into fuse boxes in the so-called Sunnyside yards of the Pennsylvania railroad in Long Island City. Probably there wasn't more than a pint of the stuff that did the business, but no pint of booze ever accomplished so much mischief so quickly. For at 4:27 o'clock, trains scooting across Long Island plains suddenly grew tired and stopped. Trains scooting across the New Jersey meadows did the same. Also trains which had been roaring through black tubes beneath two rivers—the East and the North—stopped roaring and died, with lights out. Just for good measure, trolley cars in Queens, Nassau and Suffolk counties also stopped. The trains advertised with important sounding names were just as impotent as the dinky 5:15's. Not until 6:15 was the mischief repaired and by that time even the vast waiting room of the Pennsylvania Terminal was hardly large enough for the throngs. As for the unlovely little brown and red stations in Brooklyn, they sent waiting crowds of suburbanites out into the drizzle of the cheerless Brooklyn streets.

Increased Use of Electricity in Norway

The continued rapid extension of the hydroelectrical development of Norway seems assured. In addition to the extensive plans which have been formulated and are being carried into effect relating to development of water power in nearly all sections of the country, there has been begun an active campaign for bringing before consumers the value and economy of electric power. Even now, in some sections of Norway, electricity is used for running sawmills and heating homes in districts where timber is the principal produce marketed.—*U. S. Commerce Report No.* 172.

PERSONALS

KENNETH R. HARE has been appointed district manager for the Transportation Engineering Corporation, New York, with headquarters at Chicago, in charge of the territory in the middle west, including Chicago, St. Louis and other important railroad centers. Mr. Hare graduated from the University of Wisconsin in 1911, with the degree of electrical engineer, having spent his vacations on railroad location and construction in northern Minnesota, as concrete inspector, and later in connection with transit and level work, estimates, etc. He also did considerable work in connection with the electrical construction, installation of dynamo electric machinery, transformers and switchboards for the Duluth Edison Company and the General Electric Company. After graduation he took the test and shop course at the Schenectady works of the General Electric Company, following this in 1912, with construction and meter work for the Great Northern Power Company, Duluth, Minn. Later, in the same year, he was appointed chief electrician for the Northern Pacific Railroad in charge of all electrical work from St. Paul to the Pacific Coast. In 1915, he was appointed associate editor and later became managing editor of the *Railway Electrical Engineer*, published by the Simmons-Boardman Publishing Company, New York. He left this position in 1917 to enter military service as first lieutenant in the Ordnance Department. In 1918 he was appointed, on behalf of the



K. R. Hare

Government, assistant superintendent of the munition plant of the American Can Company, Kenilworth, N. J., in direct charge of the high explosive plant, remaining in that position until the work of the plant was about finished, and now becomes district manager of the Transportation Engineering Corporation, which is the authorized representative of the Edison Storage Battery Company in the sale of storage batteries to railroads, and of the Automatic Transportation Company in the sale of industrial trucks and tractors to railroads.

J. R. Smith, chief electrician of the Minneapolis, St. Paul & Sault Ste. Marie with headquarters at St. Paul, Minn., has been appointed signal supervisor succeeding E. B. Dodd with headquarters at Minneapolis, Minn. Mr. Dodd has been assigned to other duties. S. D. Dimond succeeds Mr. Smith as chief electrician.

F. S. Wallace, formerly foreman-electrician with the Pullman Company at Jacksonville, Fla., who has been with the Signal Corps, U. S. Army, since December 1917, has returned to the employ of the company as electrical repairman in charge with headquarters at Augusta, Ga.

John Roedel, who for the past twenty years has been engaged in the car lighting industry, has withdrawn from this business to devote his time to a comparatively new field, namely, making crucibles for metallurgical work. Mr. Roedel began his career in car lighting work with the Gould Coupler Company in 1898 and is responsible for a great many of the early installations made by that company. In 1907 he joined the Bliss Electric Car Lighting Company of Milwaukee, Wis., and remained with that company until its absorption by the U. S. Light & Heat Corporation. He continued in the employ of the latter concern until his recent change. Mr. Roedel's friends wish him every success in his new venture.

OBITUARY

Oscar Otto, general superintendent of the South Philadelphia Machine Works of the Westinghouse Electric & Manufacturing Company, died on Monday, June 30, as a result of fatal injuries received in an automobile accident. The car in which Mr. Otto was riding was side swiped and completely demolished by a heavy army truck on a steep grade near Westgrove, Pa.

Mr. Otto was born in Manitowoc, Wis., on January 2, 1859. After finishing his apprenticeship course as a machinist in the Manitowoc shops of the C. & N. W. Ry. and later serving several years at various places in the state of Wisconsin, he accepted a position with the Northern Pacific Railroad Company at Tacoma, Wash., going from there to the Oregon Short Line at Salt Lake City. He returned in 1898 to the Chicago & North Western Railroad as superintendent of their Chicago shops. In June, 1909, he accepted a position as general superintendent of the Westinghouse Machine Works at East Pittsburgh. When the Westinghouse Company opened their new plant at Essington, Pa., Mr. Otto supervised the installation of the machinery; later, in February, 1918, he was permanently transferred to the new works, where he remained until his death.

TRADE PUBLICATIONS

Better Results From Present Lighting Equipment is the title of a small illustrated envelope folder recently issued by The Thompson Electric Co., Cleveland, Ohio. The folder shows and explains the advantages to be obtained by the use of the Thompson Safety Disconnecting Hanger in shops where lighting units are suspended above traveling cranes.

Reactions, the quarterly publication of the Metal & Thermit Corporation, New York, in the second issue for 1919 contains some interesting photographs together with a complete description of the repairs made by the Thermit welding process upon the broken stern post of the U. S. S. *Northern Pacific.* It will be recalled that this was the vessel that ran aground in a dense fog, off Fire Island, Long Island, N. Y., on January 2, 1919.

The Electric Storage Battery Co., Philadelphia, Pa., has recently revised its booklet describing and illustrating the "Ironclad-Exide Battery." The booklet which is now being distributed is 4 in. by 6½ in., and contains 24 pages entirely devoted to sketches of the important parts of the battery, together with complete information concerning the details of their development and the importance of their relation to the storage battery industry.

The Wellman-Seaver-Morgan Co., Cleveland, O., has developed a four-page pamphlet for distribution among engineers and draftsmen. In the strict sense of the word the pamphlet is not a trade publication as it does not mention any of the products manufactured by the company. It consists of three series of curves from which may be determined the relations in any shaft between power, shaft diameter, torsional stress and speed.

Sprague Electric Works of General Electric Company, New York, is distributing two small booklets illustrating and describing the Sprague Electric Ozonators. One of these booklets describes the smaller sized machine for domestic use, and the second explains the uses of the larger type in cold storage warehouses. The purification principles underlying these devices are also briefly sketched. The smaller machine is intended for operation on the ordinary 110 volt circuit, and the larger type may be had for use on 110 or 120 volt, 25 or 60 cycles, alternating current or 110 or 220 volt direct current.

"C-H Mine Duty Apparatus" is the title of a new 8-page 8½ in. by 11 in. booklet, just issued by The Cutler-Hammer Mfg. Co., Milwaukee, Wis. This new booklet makes special reference to the Cutler-Hammer Mine Duty Apparatus installed in the plant of the St. Louis Smelting & Refining Co. at St. Francois, Mo. A detailed description of the method of handling the ore from the three levels of the mine until it is ready for shipment, is given. Special emphasis is laid on the hoist and conveying machinery and the C-H Automatic Control and Safety Apparatus used on this machinery. The illustrations show the mine hoist control panel, master switches, limit switches, overspeed governors and electrically operated brakes; also the automatic starters for the crushers and conveyors. These starters are controlled from push button stations and the speed of the conveyors and crusher is governed by armature regulators. The front and back covers of the booklet display a panoramic view of the buildings above the mine, including everything from man-hoist to chat dump.

Railway Electrical Engineer

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YESTERDAY AND TOMORROW

Years ago, before Mr. McAdoo's magic wand had touched the wage scales of the railroads, the average railroad man was very much underpaid and oftentimes overworked. He grumbled some to be sure, but he stuck to his lot with traditional loyalty. Railroading then was a matter of practical experience in all of its departments. Promotions came by virtue of seniority and no great amount of education was considered necessary. Electric power stations were unheard of so far as railroads were concerned. Telephones were confined to commercial lines exclusively and with no overwhelming degree of success. Electric arc welding was still unborn. Electric locomotives, third rails and overhead trolleys had never even been visualized. Coaches were lighted with gas and stations with kerosene.

How different are the days of the present! What a wonderful opportunity is spread out before the young railroader today compared with the man of a generation ago. For all classes of railroad employees the long hours have been shortened, and the low wages have been increased, until today the railroad worker stands on an equal or better footing with other workmen in other lines of endeavor.

As railroad labor has risen to a higher plane so too have the opportunities to demonstrate individual ability arisen in the various lines of modern improvement. Today the railroads have adopted practically every invention of proved worth that is applicable to their needs. The addition of these modern developments necessitates men of special training to handle and supervise them with the result that exceptional opportunities are open to young men who have an earnest desire to lift themselves above the rank and file.

There is perhaps no other development which calls for a more studious application than the various branches of electrical work. It is absolutely impossible to acquire anything like a complete knowledge of this intricate subject by practical work alone, and many hours of diligent study must be spent on the theoretical side of this wonderful science by the man who would become a successful electrician. He must be able to combine theory and practice. Practice he can acquire in his daily work but theory can be gained only by study and is best obtained under the guidance of a competent instructor. Very shortly the technical evening schools will be opening their fall classes in the cities and towns throughout the country. To the ambitious young electrician these schools offer a means of obtaining from an experienced teacher an insight into the laws concerning the behavior of electricity and magnetism. The successful electrician must have this knowledge and no better opportunity could be afforded to secure it than through the evening schools. Success calls; the ambitious few heed, while the sluggards sleep their time away. In which class do you belong?

THE COMING CONVENTION

How conditions change in one short year! Last fall the Association of Railway Electrical Engineers met to hold its wartime convention in Chicago, thoroughly appreciative of the importance of the gathering and filled with mingled feelings of patriotism and enthusiasm. Each man came with the desire to derive the utmost benefit from the committee reports and discussions so that he might carry away with him something that would increase the efficiency of his own department. The earnestness of the members was just as apparent in the discussions as it was at the wartime dinner at the close of the convention when they sang "The Stars and Stripes Will Float Over Germany Before the Boys Come Home." There was no reason then to suspect that the great war was so nearly over and the spirit of determination voiced itself in that little impromptu song.

Today, the problem is different. A year ago our troubles were all abroad; now they are all at home and what is more to the point a lion's share of them is on the railroads. There is just as much need for earnestness, interest, enthusiasm and active participation in the convention this fall as there was a year ago. The eternal problems of efficiency if anything seem more insistent upon solution this year than ever before. The turmoil, unrest, discontent and dissatisfaction that are manifest on every side clamor loudly for relief. In the crisis each man must do his full duty and this can best be done by taking counsel with his fellowmen.

The electrical engineers of the railroads have their duty to perform just as surely and certainly as any of the others. The need of the hour in the manufacturing industries is more production—on the railroads it is greater efficiency. The two terms are like the Siamese twins; they cannot exist separately. Are you absolutely certain that you are handling your electrical problems in the most efficient manner?

The brief June convention of the association at which the committee progress reports were read proved conclusively by its large attendance that the subjects were live ones. The months that have intervened since then should have increased the interest in these subjects so that every man should come prepared to discuss the reports and profit by the diversified opinion presented by others.

The exhibits cannot, of course, compare in extent to

the immense exhibition of the June convention. It is too early to predict just how many exhibitors will use space but it is quite apparent that while the exhibits may not be so extensive they are bound to be more intensive. One of the greatest disadvantages of a large exhibit is that one's time is spread so thin that many of the desirable features can be investigated only superficially or perhaps not at all. This will not be the case at the coming convention for the devices shown are all certain to be of interest to electrical men and will not be so numerous that ample time cannot be given to a careful and thorough study of each.

WHAT IS YOUR ATTITUDE ON THE WAGE QUESTION?

A number of experiments in what has come to be designated as industrial democracy are now being conducted, notably in the steel industry, the outcome of which it would be unwise to predict. They are all based on the same fundamental principle, namely, that the management on one hand and the workmen on the other, have equal rights to a voice in the determination of the conditions under which they must work together. Whatever results of the detailed plans which have been put in practice may be, the principle on which they are founded is sound and the experiments may well be watched with the keenest of interest.

Such democracies are in effect in the works of the Midvale Steel & Ordnance Company, the Cambria Steel Company and subsidiary companies, and the action taken by the representatives of the employees of these companies at Atlantic City, August 22 and 23, in adopting a resolution condemning the persistent demands of workmen generally for shorter hours and higher wages offers a strong contrast to the general condition of unrest and suspicion in the greater part of the industrial world. The resolution states that "the high cost of living needs to be abated by diligent, efficient and conscientious labor, by thrift, and by avoidance of waste and extravagance," and that "the price of commodities is regulated by the day's work of a man and the real unit of value or unit of compensation is not a dollar but the purchasing power of a dollar," which is regulated by the average compensation for one hour's work received by all who labor. The resolution further states that "we believe any workman who demands a greater proportionate return for his labor than his fellow workmen in other lines are getting, is as guilty of profiteering as a grocer who charges exorbitant prices for necessities of life."

It is worthy of note and highly encouraging that the representatives duly elected by the great bodies of employees of the various plants of the Midvale and Cambria companies, numbering some 30,000, have so sound an understanding of the fundamental necessities for the improvement of the present unsatisactory economic conditions. The pertinent fact in this connection is that the Midvale employees are organized under what has been designated as the shop committee system for selective bargaining and consideration of grievances and working conditions with the local and general management of the company, an organization which tends to promote open dealings and mutual freedom from suspicion.

It is a question whether the great mass of workers in the country at large are not as sound in their estimate of the situation as the Midvale employees, the difference in expression being due largely to the general feeling of suspicion between wage earners and employers, which apparently does not exist in the relation between the Midvale company and its employees.

REGENERATION OF POWER BY ELECTRIC LOCOMOTIVES

For the first time under regular operating conditions, power has been regenerated to the line by electric locomotives equipped with single phase series motors. This was done in Switzerland. Road tests, on the recovery of the electrical energy which the braking on down-grade movement renders available, were made on the Lötschberg line of the Swiss Federal Railways on June 27. The system tried was that of the Maschinenfabric Oerlikon and the success is described as complete.

Regeneration for three-phase railways, such as that of the Great Northern through the Cascade tunnel, has long been practicable, as it is an inherent characteristic of the three-phase motor to return electric power to the line when mechanical power is applied to the motor shaft. No special switching apparatus is required to make the motors operate as induction generators.

In the same general way, regeneration applies to the single phase system used on the Norfolk & Western, as the motors on the locomotives are three-phase motors. When regenerating, the motors develop three-phase energy at a low voltage which is changed by transformers and a rotary phase convertor on the locomotive to single phase power at 11,000 volts and returned to the line.

It was made practicable for direct current operation in the design of the equipment now in use on the Chicago, Milwaukee & St. Paul. In this case the motors are separately excited by a motor generator set in order to make them function as generators and in the new locomotives now under construction by the General Electric Company and the Westinghouse Electric & Manufacturing Co., improvements will be made on the method of developing exciting current.

In the case of single-phase series motors, one motor is separately excited from a transformer, and it supplies exciting current for the other motors which then function as generators and return power to the line. The particular significance of this development is that regeneration can be had without regard to the type of equipment and kind of electric power used.

NEW BOOKS

Induction Coils in Theory and Practice. By Professor F. E. Austin. 64 pages, 45 illustrations, 5⅝ in. by 8⅝ in. Bound in cloth. Published by the author. Box 441, Hanover, N. H.

The book is divided into 16 lessons, written in simple language, describing the fundamental theory underlying the design and operation of induction coils, how to use and build them, including all sizes, from small telephone coils to those of large capacity used for wireless operation and X-ray apparatus. It also tells about condensers, electrolytic and mechanical interrupters and "Telsa" coils. In order to assist in understanding the text, numerous examples and problems are given. Of necessity some mathematics have been introduced, but only a small portion involves the higher branches.

Electrical Equipment of B. & O. Glenwood Shops

Facilities for Lighting, Power and Electric Arc Welding Representative of Good Modern Practice

THE locomotive repair shop recently completed by the Westinghouse, Church, Kerr & Co. for the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., with the new equipment installed, represents an expenditure of more than $1,700,000. The nature of the new shop layout was largely controlled by the rigid limitations of space imposed by the old shop site, most of which is included in the new shop, as no site for general relocation was available. The construction work involved engineering difficulties which electrical men can appreciate as it was necessary to maintain electrical service in the old shop as the new one was built over it and to provide service for machines as they were moved from one shop to the other.

The old shop was housed in a group of buildings starting with an old roundhouse which was used as an erecting shop, adjoining one end of which was the machine shop. The blacksmith's shop, boiler shop and tank shop occupied three steel frame buildings with corrugated sidings adjoining the end of the machine shop in the order named. Between the boiler shop and tank shop was located a transfer table. These latter three buildings were practically all included within the site of the new shop and continued to house their respective shops until the new structure was erected, after which they were torn down and the equipment rearranged in its proper location in the new building. No definite plans for the old shop buildings have been settled upon, but it is expected they will be used for miscellaneous repair work in the car department; mounting of air brake and steam hose and storage of bulk material.

General Description

The new shop is of the longitudinal type, of steel frame, brick wall construction, and has a total length of 635 ft. with a width of 232 ft. 6 in. It is divided longitudinally into four bays. The monitor bay, 440 ft. of the north end of which is occupied by the erecting shop, is 90 ft. wide. On the east end of this is a single bay, 42 ft. wide in which is located the tank shop, pipe shop, tin shop, cab shop, and part of the blacksmith shop. West of the monitor bay are two bays, both of which are principally occupied by the machine shop. The bay adjoining the monitor bay is 52 ft. wide, while the outside bay is 40 ft. 6 in. wide. With the exception of 120 ft. of the south end building, which is occupied by the storehouse, the outside bay contains a gallery floor on which space is provided for a manufacturing tool room, facilities for

Fig. 1—The Northwest Corner of the B. & O. Shops at Glenwood, Showing the Heavy Castings Platform at the Right. The Storehouse May Be Seen on the Southwest Corner of the Shop

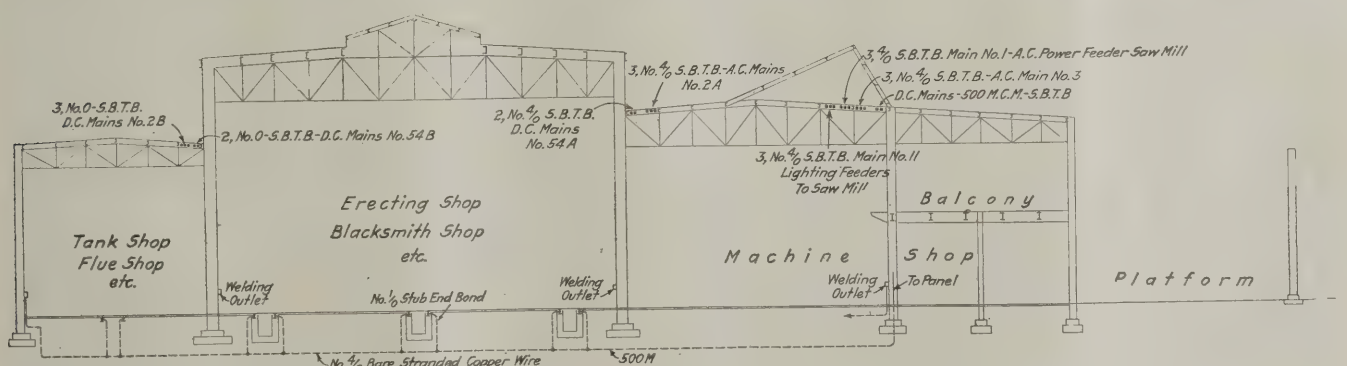


Fig. 2—Section Through Shop Looking South Showing the Position of the Overhead Feeders, Welding Outlets and Welding Return Leads

electric repairs, a millwright shop, and the air pump, stoker and injector repair shop, the apprentice school room, offices for the assistant shop superintendent, general foreman and the supervisor of shop schedules, and toilet facilities. Along the entire length of the west side of the shop building is a platform, 50 ft. wide, on which the heavy castings are stored.

An unusual feature of the shop structure is the store-

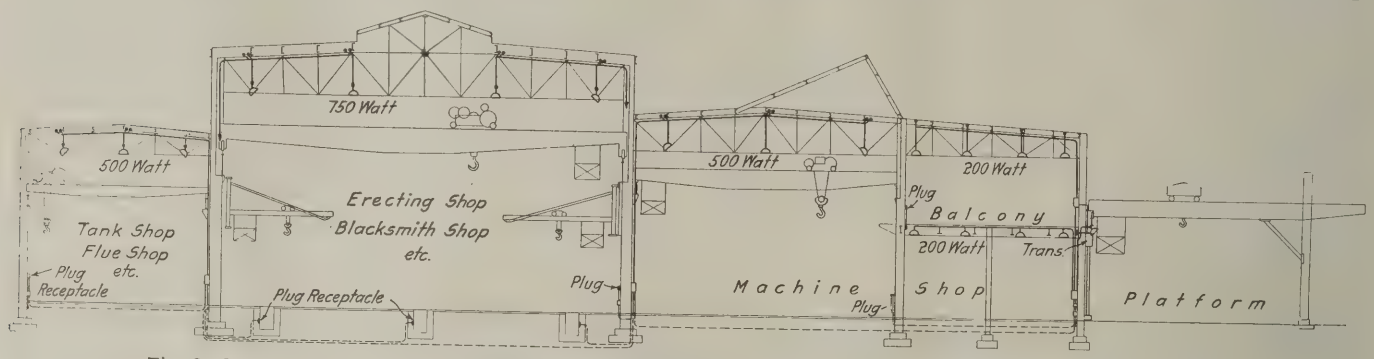


Fig. 3—Section Through Shop Looking South Showing the Location of the Cranes and the Lighting Outlets

house, within the main shop building, which occupies 120 ft. of the west bay, at the south end of the building. It is designed for six stories, five of which have been built, and is of reinforced concrete construction.

The shop is heated by hot air, the system consisting of two 200-in. direct engine-driven fans. The plant is a so-called twin system with one fan for each end of the building. Before passing through the fan the air is heated by 71-in. Ventostacks, placed two tiers high and six stacks wide. The fans discharge into concrete heating ducts, forcing the air to outlet boxes at the columns along the sides of the buildings. With the exception of the fans, the steam hammers in the blacksmith shop and the pneumatic hammers for riveting and chipping all of the machinery in the shop is electrically driven.

Power Supply

The power plant stands just west of the center of the shop building and about 50 ft. from the heavy castings platform. It is the same plant that supplied power to the old shop except for the installment of some additional machinery. It has insufficient capacity for the operation of the new shop and during the day power is purchased from the Duquesne Power & Light Company. The night load is handled by the railroad power plant. The practice of carrying the night load on the plant generators, however, is uneconomical and it is the intention of the operators to discontinue the practice. Purchased current service will be used through the summer months and during the winter months the railroad plant generating equip-

Fig. 4—The Erecting Shop Looking Toward the South End of the Moniter Bay. View Shows the Two 100-ton Bridge Cranes and One of the 15-ton Traveling Jib Cranes

ment will carry its proportion of the load as use can then be made of exhaust steam. The additional equipment consists of three 375-kva, 11,000/440 volt transformers, which replaced three of 255-kva. capacity and two 300-kw., 230-volt synchronous convertors with transformers, switching equipment, etc.

The lighting circuits use 110-volt, single-phase alternating current, 440-volt, three-phase alternating current is required for machine tool and elevator motors, and 230-volt, direct current power is used for crane motors and some of the machine tool motors.

Main Feeders

Starting at the power plant the feeders run underground to the shop and directly across the shop to the opposite wall. There are four man-holes enroute. The feeders are brought up into the shop through three of these, and the fourth which is close to the east wall of the shop is a spare man-hole. All of these feeders are varnished cambric, insulated, lead covered cables run in fibre conduits, set in concrete. There are 16 ducts in the run from the power house to the first man-hole, 12 ducts from the first to the second, 8 ducts from the second to the third, and 6 ducts from the third to the fourth man-hole. These numbers include two or more spares in all cases.

The specifications used for laying the ducts are as follows: "Concrete mixture to be 1—2½—5. All gravel stones to pass through ¾-in. mesh. Lay a 3-in. base of concrete and allow it to harden. Drain conduits toward man-holes, allowing a minimum of three-inch slope in 100 ft. Avoid pockets in line. Lay first row of conduits directly on base. To stiffen conduit system, stagger joints, use one-inch wood or concrete spacers between ducts. Horizontal spacers two per length and vertical spacers one per length of duct. Withdraw vertical spacers. All joints are to be thoroughly painted, not dipped, with insulating compound. Work concrete well in around ducts. All fibre ducts to be 4 inches in diameter, and all man-holes to be 4 ft. 0 in. by 4 ft. 0 in. in size."

Several feeders are brought out from each of the first three man-holes and are carried to dead front safety switches and circuit breakers contained in steel cabinets which are mounted on the vertical columns supporting the roof. From the switches the feeders are carried up the vertical column in rigid metal conduits and are brought out of condulets near the roof. The cables used in these conduits are rubber covered double braid cables. From the condulets the cables are connected to open runs of feeders which extend the entire length of the shop just under the roof. The location of these runs of feeders are shown in Fig. 2. These open runs of feeders are mounted on porcelain insulators and tension is maintained on them by strain insulators located at the ends of the shop. These feeders carry power for machine tool motors, cranes and for the motors which drive the electric arc welding generators.

Fig. 5—Looking North in the Heavy Machine Tool Bay Showing the Day Lighting and the Location of the Lighting Outlets

Branch Motor Wiring

The branch feeders for carrying power to shop motors are tapped on to the main feeders just under the roof and are brought down the vertical columns in rigid metal conduits through dead front safety switches and fuse cabinets such as shown in Fig. 6. In the fusebox the branch feeder is sub-divided and circuits are carried out to the motors driving individual machines or group of machines. In the fuse cabinet it will be noticed that there are three sets of fuses with four fuses in each set.

Four three-phase circuits are carried out from this cabinet and the fuses are so arranged that all of the fuses in each group are of the same potential.

From the fuse cabinet the circuits are taken to the motor through rigid metal conduits set in the concrete floor. The conduits are run directly from the cabinet to the motor by the shortest possible route in the manner shown in Fig. 7. This illustration shows the arrangement used for seven of the groups in the machine shop.

The conduit rising from the floor is connected directly to the starting box or is terminated in a condulet close to the starting box. A typical arrangement of motor wiring is shown in Fig. 8. Here it will be noticed that the starter is on the side of the machine opposite the operator. In all such cases the machines will be equipped

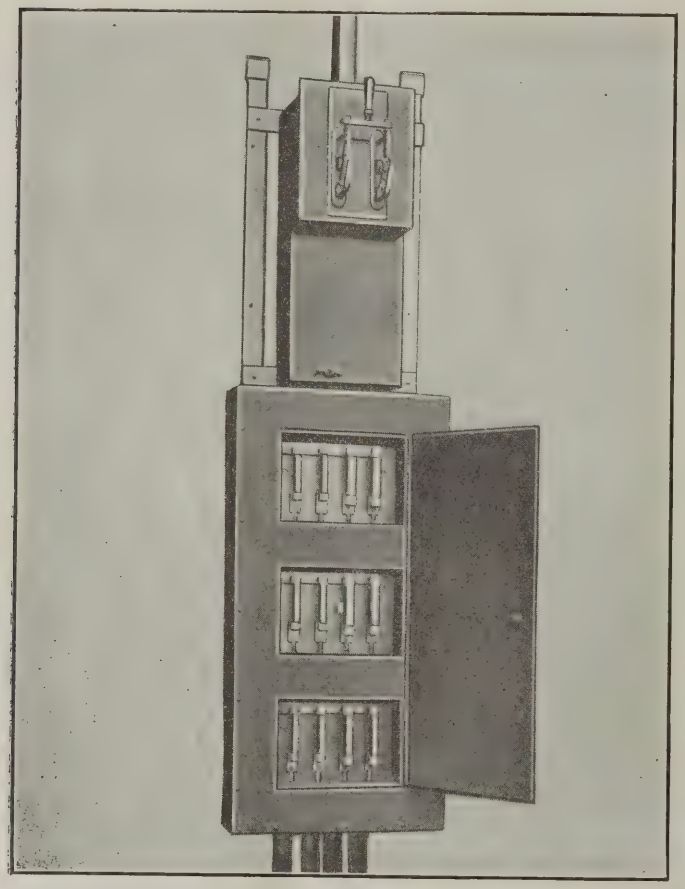


Fig. 6—Cabinets for Branch Motor Wiring. This Panel Supplies Four Three-Phase Circuits

with emergency push buttons for tripping the starter or circuit breaker located at convenient points.

Cranes

The shop is equipped with ten traveling cranes and about 15 one and two-ton electrically operated Yale hoists mounted on swinging jibs. There are two 100-ton bridge cranes and four 15-ton jib cranes which operate over the entire length of the monitor bay. In the east bay, which includes the tank shop, flue shop, etc., there is a 30-ton bridge crane which operates over the entire length of the shop and a similar 15-ton crane in the west bay, which includes part of the machine shop. The heavy castings platform, which extends along the entire length of the west side of the shop building, is served by a 15-ton half gantry crane for about four-fifths of its length. The location of all of the above mentioned cranes is shown in Fig. 3. In addition to them there is a 50-ft. span, 15-ton bridge crane, which operates across the south end of the building.

There are two Otis freight elevators used for carrying material between the machine shop floor and the balcony,

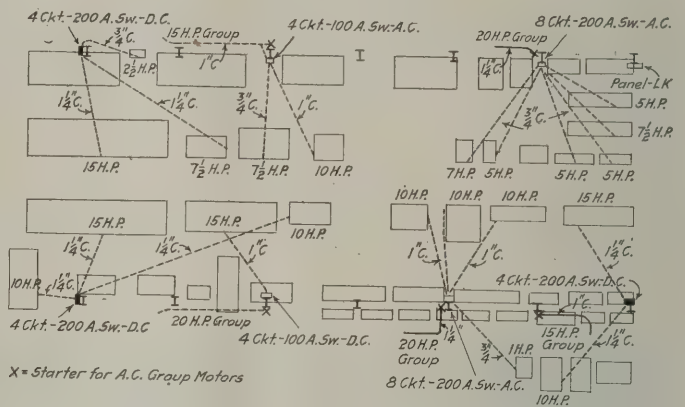


Fig. 7—Diagram Showing How the Individual Mortor Circuits are Carried from the Panels Such as Shown in Fig. 6 to the Motors. Diagram Includes a Section of the Machine Shop.

one of which also serves the storehouse, and an Otis automatic passenger elevator which serves the four floors of the storehouse and the main office on the fifth floor.

All of the cranes are operated by the 230-volt direct-

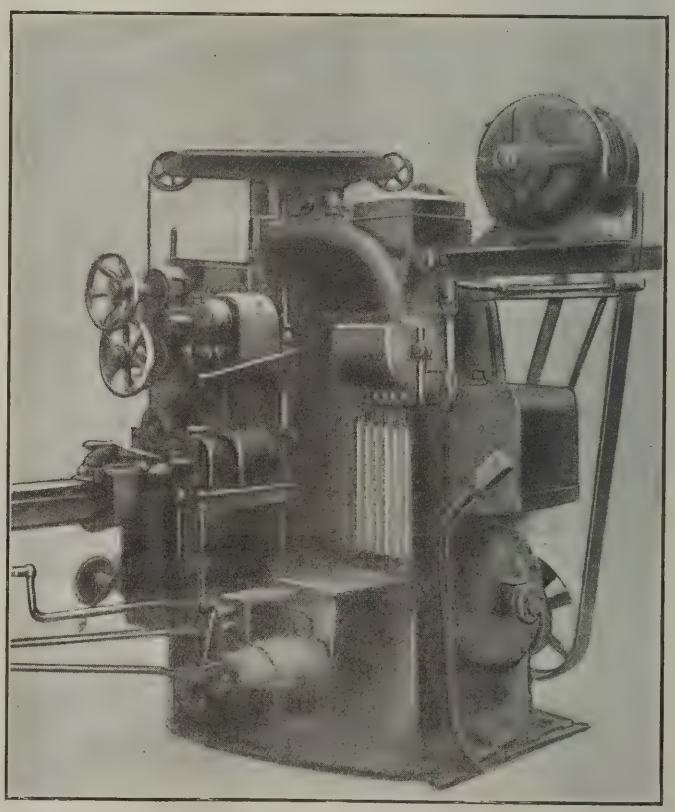


Fig. 8—Typical Machine Tool Motor Wiring

current power, and 440-volt alternating-current power is used for the elevators.

Welding Equipment

The welding circuits were laid out so as to allow maximum flexibility. No portable welding machinery is used, but with the equipment as installed it is possible to use the entire welding capacity of the shop in any quarter of the shop.

There is one motor generator welding set located near the center of the building on each side of the monitor bay. The sets are mounted on platforms and one of them is shown in Fig. 9. Both of the sets are Westinghouse constant voltage type welding machines; one has a capacity of 1,000 and the other of 500 amperes. There are eight welding panels in the switchboard underneath the sets and there are eight circuits of No. 1 wire, extending both north and south from the switchboard about 130 ft. in each direction. Each of these four sets of eight leads terminate in the center or generator panel of a station such as is shown in Fig. 10. Eight similar leads extending across the shop between opposite stations connect the eight terminals of the shop or transfer panels of the station. From the 24 outlets in the lower panel of the station leads are carried out to the welding outlets such as shown in Fig. 11. The outlet shown in the illustration is a double circuit outlet.

Only the negative sides of the circuits are carried through the welding switchboard panels, transfer panel stations and to the welding outlets. Common positive return circuits are used, consisting of track rails bonded together and bare copper feeders of varying sizes connected to the positive bus of the welding set. The arrangement of the return or positive feeders is shown in Fig. 2.

The double welding outlets are provided for the purpose of facilitating the use of two welding circuits in parallel for carbon welding work as well as to permit a greater number of operators to work in one location when doing metal electrode welding work. There are 24 circuits provided for, making a total of 96 welding outlets. Of these 88 have been installed.

In doing welding work on locomotives resting on their own wheels, no cable connection is required for the return circuit, as the locomotive is already grounded. For unwheeled locomotives a jumper is attached between the locomotive frame and the track. This practice is also followed for bench and similar character welding work where there is no normal ground return. Suitable ground connection outlets are provided for this purpose near welding outlet locations, which are not readily available to rail return.

A diagram of the welding distribution system is shown in Fig. 12. This drawing does not show the leads which extend from the station to the welding outlets, or the return circuit to the welding generator. Suppose, for example, that the entire capacity of the welding panel shown in the lower part of the drawing is being used from the outlets leading from station No. 3, and it is desired to connect panel No. 9 to welding outlet No. 26. The operator goes to station 2 and with a plug cable connects receptacle No. 9 to one of the receptacles in the transfer panel, for example, the receptacle *K*. Then going to station No. 4, with a plug cable, he connects receptacle *K* in the transfer panel to receptacle 26 in the outlet panel. This energizes outlet No. 26 and he is ready to connect his welding leads and go to work. In the same manner any welding panel may be connected to any outlet in the shop.

On each of the welding panels there are four single-pole, double-throw switches. By using these switches in various combinations, the welding current may be varied in 15-ampere steps, from 15 to 225 amperes. Where more capacity is desired, as for carbon electrode welding, two panels may be connected in parallel. In this way any valve of current may be had in 30-ampere steps, from 30 to 450 amperes.

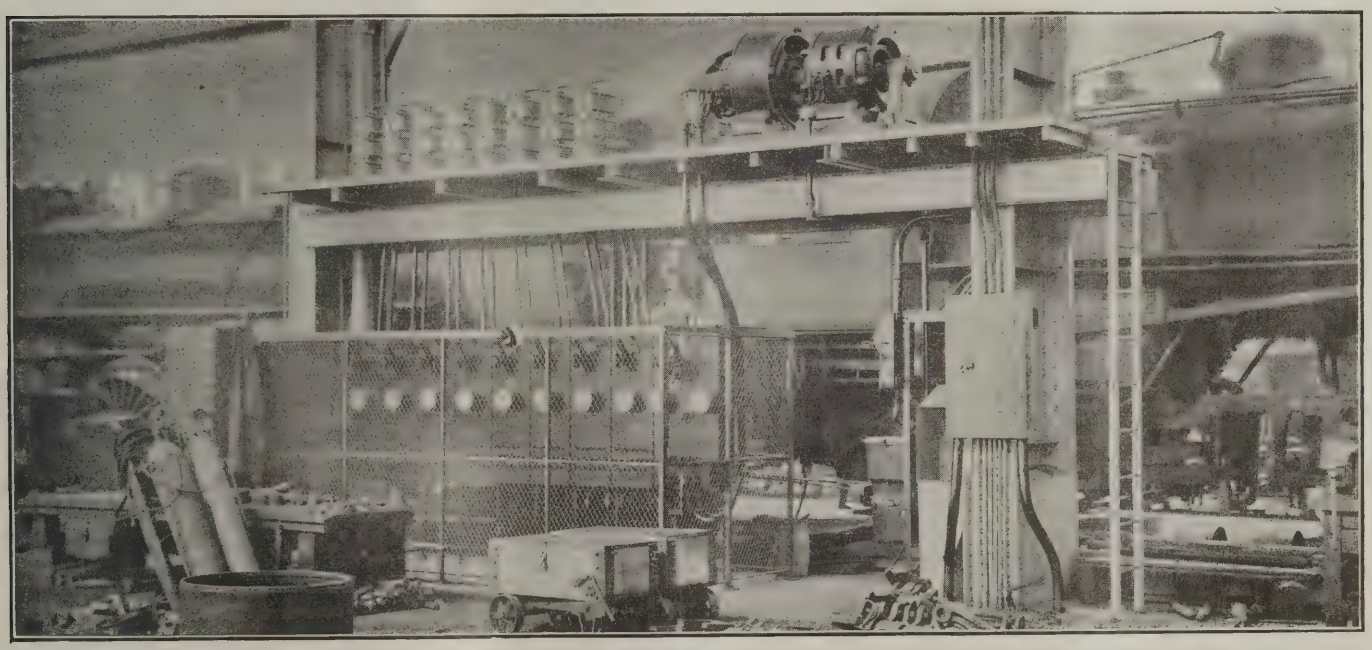


Fig. 9—One of the Two Electric Arc Welding Sets

Lighting

Good general lighting is provided for the entire shop and individual lights for separate machines have been dispensed with insofar as possible. The monitor bay is provided with four rows of 750-watt incandescent lamps, placed 22 fet. apart. The lights in the two center rows are fitted with Benjamin deep-bowl reflectors, while those in the outside rows are fitted with angle reflectors. All of the lights are placed above the cranes and the location of the rows is shown in Fig. 3. The lights in adjacent rows are staggered.

The north end of the east bay is provided with three

rows of 500-watt incandescent lamps, placed on 36-ft. centers. The two outside rows have angle reflectors, and the center row has deep-bowl reflectors. In the south end of the east bay the center row of lights is eliminated.

The inside west bay is lighted in the same manner as the north end of the east bay, except that the lights are placed on 22-ft. centers. Under the gallery there are four rows of 200-watt incandescent lamps in deep-bowl reflectors 51 ft. apart, and the same placing of lights is used in the gallery.

One of the angle reflectors containing a 750-watt unit is shown in Fig. 13. The small box in the stem is a fuse box. The fuse box is provided in each individual lighting unit for the reason that the present Underwriters' rules limit the lighting load on a branch circuit to 1,320 watts, dependent upon the final cutout. In the distribution layout used in this shop, the branch circuit loads are as high as 3,000 watts per circuit. The type of lighting equipment used in the storehouse and in the office are shown in Figs. 14 and 15.

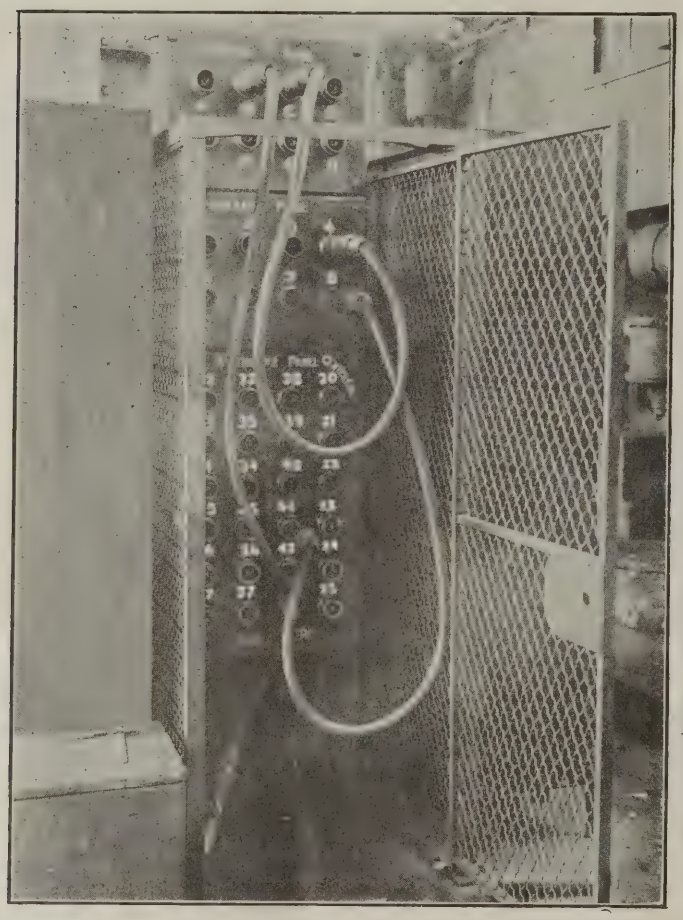


Fig. 10—One of the Four Welding Stations

Power for the lighting circuit is taken from the 440-volt, three-phase feeders. The lighting feeders are tapped from the main feeders in the first man-hole and the circuits carried through rigid metal conduit in the floor to four transformers, mounted on the west wall of the shop over the heavy castings platform. These transformers are placed at regular intervals along the side of the building, and transform the voltage from 440 to 110 and 220. The three-wire, 110-220-volt circuits are then carried from the transformers straight across the shop to distributing panels located along the run, as shown in Fig. 16. In this illustration the two feeder conduits are the black conduits entering the bottom of the distributing panel cabinet. The conduits extending from the top of the cabinet carry the overhead lighting circuits and the galvanized conduits extending from the bottom of the cabinet carry extension outlet circuits. The location of the extension outlets is shown in Fig. 3.

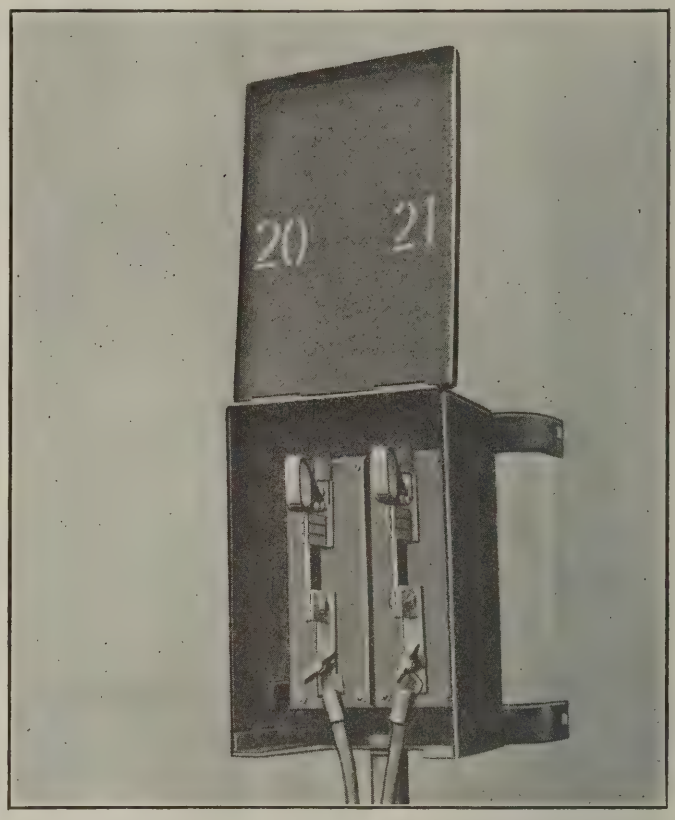


Fig. 11—A Two-Circuit Welding Outlet Panel

The overhead light circuits are worthy of particular mention. They are carried to the ceiling up the vertical column in rigid metal conduit, but are run open along the shop on top of the top chord of the roof truss. Two single runs of wire serve all of the lights in a single row over the entire length of the shop, 635 ft. These runs are split up into sections by porcelain sectionalizing in-

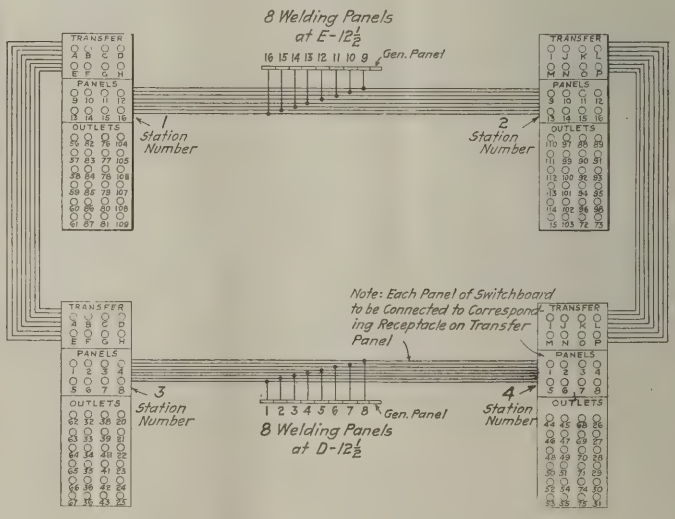

8 Welding Panels at E-12½
16 15 14 13 12 11 10 9
Gen. Panel
TRANSFER
PANELS
OUTLETS
1 Station Number
2 Station Number
3 Station Number
4 Station Number
Note: Each Panel of Switchboard to be Connected to Corresponding Receptacle on Transfer Panel
1 2 3 4 5 6 7 8
Gen. Panel
8 Welding Panels at D-12½

Fig. 12—Diagram Showing Arrangement of Welding Circuits. Individual Outlet Circuits Leading from Outlet Panels and Returns to Generator are Not Shown.

sulators. The circuits from the distributing panel tap on to individual sections and there are from three to six lamps connected to each section depending upon the size of the lamps. Along with the rest of the electrical equipment, the shop is fitted with an electric timeclock system.

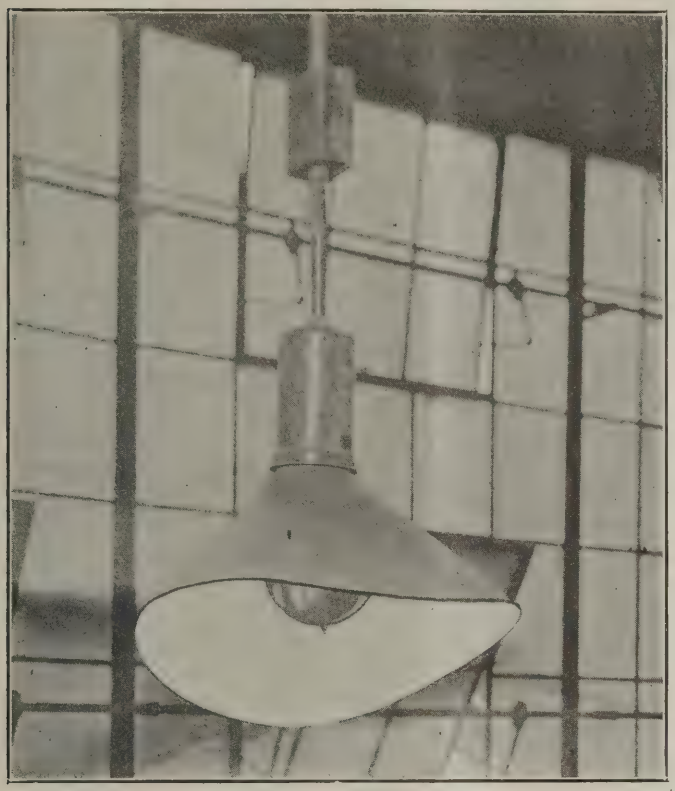


Fig. 13—Type of Benjamin Angle Reflector Used

There are sixteen branch clocks located at various points in the shop, and one master clock located on the south wall of the balcony.

During the construction of the new shop the organization in Glenwood was severely handicapped. Conditions demanded that locomotive repairs continue and output consistent with the old shop facilities was aimed at during the period in which machine tools were being moved from their locations in the old shop to the positions which they now occupy in the new shop. This has substantially been accomplished, the work gradually being concentrated in the new shop as the completion of facilities and the placing of machines would permit.

Fig. 14—One Floor of Storehouse Showing Arrangement of Lighting Outlets

Fig. 15—The General Office. Lighting Fixtures Are of the Totally Enclosed Direct Type

The construction of the new shop at Glenwood is part of a general plan to relieve the severe shortage of back shop facilities on the Baltimore & Ohio, which also includes a similar but smaller shop at Cumberland, Md. Prior to the construction of these two shops the main

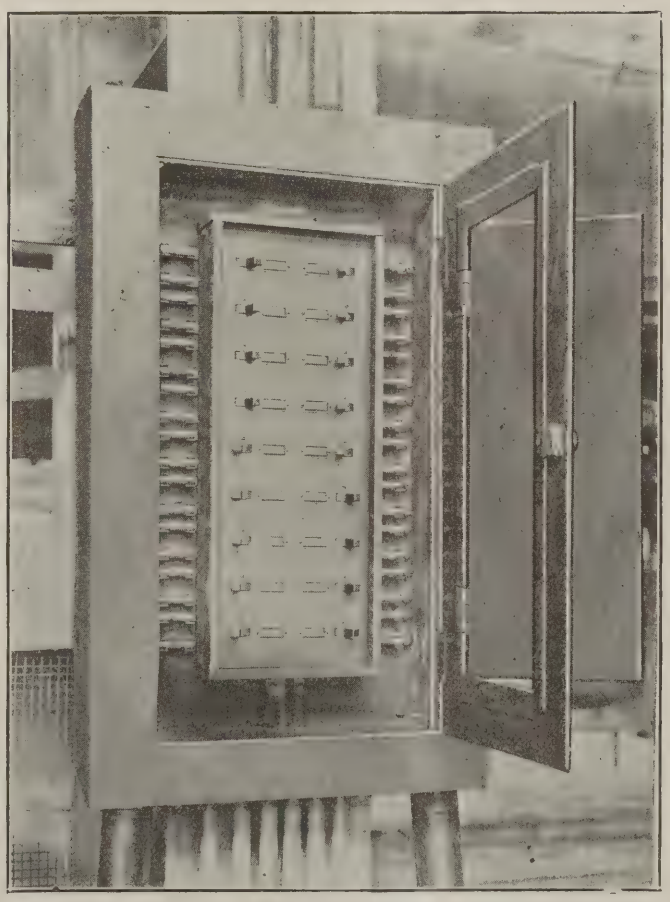


Fig. 16—Type of Lighting Control Cabinet Used Through the Shop

shop at Mt. Clare, Baltimore, Md., was practically the only plant capable of taking care of heavy repairs on an extensive scale on the road, and for some time it has been the practice of the road to contract with the Baldwin Locomotive Works for the handling of some of the heavy repair work.

THE ELECTRIFICATION PROBLEM IN ENGLAND

In a speech by Major Philip Dawson to the members of the Association of British Chambers of Commerce delivered recently and quoted in the Railway Gazette of London, important references were made to the extension of electric traction on railways. The speaker's experience and service to the Brighton Railway in this respect gave additional weight to his remarks, from which we extract the following:

The reasons which have so far brought about electrification are: congested suburban and interurban traffic; tunnel lines with difficulties of ventilation; mountain heavy grade lines; congested lines and difficulties at termini in which electrification will obviate costly widenings; electrification in countries in which coal does not exist but where abundant water power is available. The factor which limits the possibilities of electrification is the capital expenditure involved in the contract, distributing and transmission system and which will be about £5,000 per mile of single track. Interest, sinking fund and maintenance will be chargeable upon this, and this amount will have to be added to the ordinary working expenses and divided over the units of traffic per car, per ton and per passenger or train-mile. How vast this expenditure might be is shown by the fact that there are over 50,000 miles of single track in the country. It is obvious that the denser the traffic the smaller this unit charge becomes. As regards the other operating expenses, including cost of power and maintenance, other things being equal, electrical haulage generally comes out best.

An additional point made in favor of electric haulage is that, provided the generating station supplying power can be economically loaded up, electric haulage will tend towards an economy in coal consumption. The most sanguine American partisans of electrification claim a saving of over 66 per cent in coal on this basis, which would amount to about 10,000,000 tons of coal per annum in Great Britain. Against such a saving must be set off the capital charges already referred to.

The problem of electric power supply will in many cases be tied up with the question of electrification; but this will not always be the rule. There is little doubt that in an industrial area where electric supply stations already abound, and where dense mineral, goods and passenger traffic exists, electrification will be good business, so that we may anticipate the electrification of a very large portion of our railways in such areas as Glasgow and the North East Coast, as well as the counties of Yorkshire, Lancashire, Cheshire, Derbyshire, Staffordshire and parts of Worcestershire; Warwickshire and South Wales. In all these cases, owing to the good industrial loads obtainable, power stations will be in relative proximity and electrification can be classified under the heading of short distance electrification.

As regards long distance electrification, the applications in this country will be far less numerous, as coal abounds and water power is scarce, and electrification will only pay in the case of dense traffic, where the railway load will be such as to provide a good load factor for the power station. There are relatively few lines of this description to be found in this country, and by far the best example, and which should serve as a model and from the result of which conclusions for less favorable conditions could be drawn, is that of the London, Brighton & South Coast Railway. This railway was one of the pioneers as regards electrification in London, and the results of its suburban electrification during the last 10 years have been most satisfactory, the receipts of the electrified lines being more than doubled, and but for the war the whole of the suburban lines, amounting to over 150 miles of track, would have been now electrically operated. In deciding to electrify, the directorate and management of the company fully realized that theirs was a case, not only of suburban electrification, but of the electrification of their Southern system as far as Brighton, and hence they, I think, wisely adopted a system which lends itself to indefinite extension. Here is the case of a long distance line operating heavy express passenger and freight trains with such a density of traffic that, without widenings, the train service could not materially be increased and where, owing to the density of service, a good load factor would be guaranteed for the generating stations. This is the one line ready for electrification immediately, and on which work could be proceeded with at once, as practically all the calculations have been made and the plans and specifications are available; the contracts for the suburban section were let before the war, but are not being proceeded with owing to the present uncertainties.

The putting in hand of any other electricfication would take time, as complete schemes would have to be prepared and contracts let, and there is no other long distance line as eminently suitable for electrification as that from London to Brighton. Unfortunately, present circumstances have and are materially retarding an improvement which would go a long way toward helping to cure the present overcrowding of trains, as well as to simplify and assist the housing problem, and give employment to a large number of workmen.

The completion of the suburban section would naturally be followed by the electrification to Brighton, for which plans are practically completed, and which would simultaneously result in providing plentiful and relatively cheap electricity supply throughout the whole of the purely agricultural and residential districts served by the railway.

The electrification of the suburban system would demand and justify the creation of a super-station, which would comply with the recommendations of the Board of Trade Committee on electrical power supply and which could be the first step in the unification of greater London electrical power supply on rational and business lines.

Summarizing the position as regards the future of electric power supply, the prospects are very encouraging, provided the government and legislation assist every class of electric enterprise, whilst safeguarding the legitimate interests of the consumers.

Iron and Steel and the Welding of Each*

A Study of the Effect of Arc and of the Properties, Composition and Classification of Metals

By E. Wanamaker and H. R. Pennington

IRON ore is combined usually with oxygen, carbon, silicon, sulphur and phosphorus, the combinations being known as iron oxide—brown or red in color—iron carbonate, iron silicate, iron sulphate, iron phosphate, etc. The mining of this ore and its conversion into iron and steel products forms one of the world's greatest industries. The ore is smelted in blast furnaces to produce metallic iron. The process consists essentially of the removal of the oxygen, which is combined with the iron. The product, however, is not chemically pure iron. Pure iron is a laboratory product and on account of high cost of production, it is not used commercially. The metal, which comes from blast furnaces, is known as pig iron and contains the following elements:—iron, carbon, silicon, manganese, sulphur, phosphorus, and minute quantities of gases, oxygen, nitrogen, etc. Solid solutions and chemical compounds of these elements exist in the metal, but for the purpose here desired it is sufficient to state that these elements are present in the metal in some form.

Various Kinds of Iron and Steel

Cast iron, steel, and wrought iron together, constitute the group of products which we classify under the name *iron* and *steel*. These products have two points in common: First, iron is present in all cast iron to the extent of at least 92 per cent, and in steel and wrought iron the per cent varies usually from 97 to 100; second, the per cent of carbon present and the form or physical condition in which this carbon exists

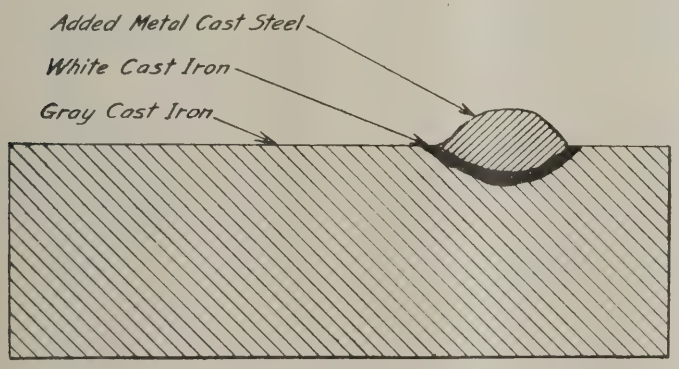


Fig. 1—In the Completed Weld There Are Three Kinds of Metal

in the metal, is the chief factor governing the physical characteristics of the finished product.

Pig iron is impure, weak, and is brought to its desired form by melting and casting in a mold. Cast iron is pig iron cast into some desired commercial shape.

Steel is purer than cast iron. It is much stronger, and may be produced in the desired form, either by melting and casting in a mold or by forging at a red heat. Forgings usually contain about 98 per cent, or more, of iron and in different samples from 1.5 per cent down to almost no carbon, together with small amounts of other ingredients or impurities.

Wrought iron is almost the same as the very low carbon steel, except that it is never produced by melting in a mold, but it is usually forged to the desired size and form. In general it contains less than 0.12 per cent carbon. Its chief distinction from low carbon steel is that it is made by a process which works it in a pasty instead of a liquid form, and leaves about 1 or 2 per cent of slag mechanically disseminated through it.

Cast Iron; Gray, White and Malleable

Cast iron has three forms; namely, gray cast iron, white cast iron, and malleable cast iron. The following is a typical analysis of cast iron:

ELEMENT	PERCENTAGE
Carbon—	
Combined carbon	0.50 to 0.75
Free carbon, or graphite	2.75 to 3.00
Silicon	1.00 to 3.00
Manganese	0.50 to 1.00
Phosphorus	0.50 to 1.00
Sulphur	0.085 to 0.15
Iron	94.665 to 91.10
Total	100.000 100.00

Gray cast iron and white cast iron may have about the same total amount of impurities. The amount of free carbon in the form of graphite in gray iron is very large. This gives the gray appearance, such as a fracture shows and from which the name is derived. Graphite having no strength of its own and being present in the metal, breaks up the structure of the body, thus leaving it porous and weak. The weakness of cast iron is therefore readily understood. Gray cast iron usually contains 2 per cent or more of graphite, and less than 1½ per cent of combined carbon. The graphite is not in chemical combination with the metallic body, but is mixed with it.

Silicon, sulphur, phosphorus, and manganese, all have an influence upon cast iron. Three per cent or less of silicon tends to decrease the amount of combined carbon consequently decreases the hardness of the product. Sulphur and phosphorus are the impurities which tend to weaken iron the most, disregarding their influence on carbon. Manganese has a varying effect. For the purpose here desired it is sufficient to state that manganese assists in counteracting the bad effects of sulphur; also it varies the degree of hardness.

Some of the disadvantages of cast iron are its weakness and lack of ductility and malleability. The last named deficiency renders it undesirable for many commercial and engineering purposes. It is used for castings that

*This is the seventh article on Electric Welding by E. Wanamaker, electrical engineer of the Rock Island Lines, and H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. Copyrighted 1919 by the *Railway Electrical Engineer*.

are to be subjected only to compression or moderate transverse or tensile strains, as for example: supporting columns, engine bed-plates, water mains, etc.

The chief advantages of cast iron are cheapness and fusibility, which makes it easy to melt and cast the product. The tensile strength of cast iron is about one-half that of steel, being approximately 28,000 pounds per square inch for soft iron. Cast iron has no elasticity and elongation before rupture.

Welding of Cast Iron

It is difficult to weld cast iron by any process under the most favorable conditions, due to the presence of the high percentage of impurities, low tensile strength, and above all the effect of a localized heat. Its brittleness, lack of elasticity and weakness, makes it necessary to foresee the effects of the phenomena of expansion and contraction especially if the pieces oppose free play. In the case of metallic arc welding, expansion and contraction are minimized to a greater extent than with any other welding process, owing to the extreme locatization of the arc flame.

When the electric arc is used for cast iron welding, about the only precaution exercised is to hold the heat in the casting to a low value by using a small size electrode with a correspondingly low heat value, and even in some cases prolonging the work. The metal should be applied in sections as has been described, in a previous article.

The welding of cast iron by means of the carbon arc

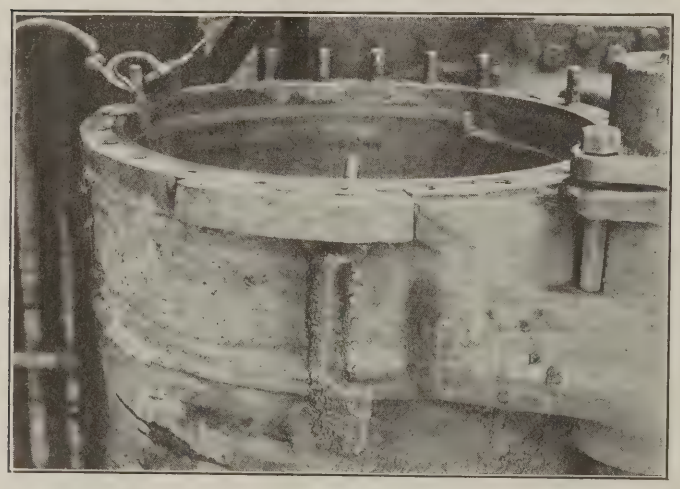


Fig. 2—Broken Cast Iron Locomotive Cylinder, Left Side Showing Fracture Partially Welded With Arc Welder

requires essentially the same precautions regarding expansion and contraction as is required with the oxy-acetylene process, in which case pre-heating is usually employed, unless the parts are small, and free to move in which case pre-heating may not be necessary.

The effect of the heat from the arc on the part to which it is applied is the most difficult obstacle to overcome in welding cast iron. The condition produced by the application of an arc on cast iron, especially the metallic arc, is the equivalent to that employed to produce white cast iron; that is when a localized heat is applied to a piece of cast iron a small area is brought up to a state of fusion and as the localized heat is moved to another location the first point heated will chill, or cool, very suddenly and prevent the precipitation of the carbon in the form of graphite; in other words the carbon will be left combined in the iron, leaving it very hard and difficult to work. For example, assume that metal has been added to a gray iron casting by means of the metallic arc process, which requires the use of an iron or steel electrode. In the completed weld there are three kinds of metal as shown in Fig. 1. The original gray cast iron immediately under the added metal or under the line of union has been changed to white cast iron on account of the chilling effect; above the white cast iron is the added metal, cast steel, the first layer of which is very hard, on account of the carbon in the cast iron combining with the steel when the two were in a molten state, in fact a portion of this first layer might be called semi-steel and on cooling, small checks usually develop. The second layer is much softer, and can be machined without difficulty.

Machining the Parts Welded

If the casting is to be machined in the welded section, it must first be annealed. In practice this is seldom done, because there are methods in use, which make it unnecessary to machine through the welded section, thus avoiding pre-heating or annealing. For example, broken cast iron locomotive cylinders are often repaired by first boring them out and applying a bushing. The fracture is then V'd out in the usual manner and iron studs are placed along the line of weld. Fig. 2 shows a weld prepared in this manner partially finished.

The studs serve a double purpose; that is, the welding is started around the studs, which makes the depositing of the metal easier, and also since the studs extend through the line of union as well as through the heat affected zone, a factor of safety is assured. Without the studs the heat affected zone usually develops checks, and finally complete rupture when subjected to alternate stresses.

Another method by which machining through the heat affected zone may be avoided in the case of welding cylinders or similar parts, is shown in Fig. 3. The soft iron or copper rod insert can be worked into place with a peening hammer and afterwards machined, or filed and scraped, to conform to the contour of the cylinder. In either case it is possible to bore the cylinder if necessary. The methods indicated above are used extensively and are known to be very successful in connection with metallic arc welding.

There are many cases where a surface can be finished with a grinder; as for example, to secure a smooth surface for a steam tight joint. There are also many cases that do not require finishing of any kind along the line of weld.

The welding of cast iron by means of the carbon arc, in most cases, requires a method very similar to that used in connection with oxy-acetylene process, since the area heated by the carbon arc process is not so localized as that of the metallic arc. It is therefore not only necessary to take very special precautions to prevent bad effects from expansion and contraction, but it is also necessary that the line of weld consists of metal that is workable.

The conditions to be observed in order to produce a weld in gray iron that is workable are: (1) Slow cooling; (2) Introduction of silicon in the welding bed;

(3) Absence of manganese. It will be remembered that rapid cooling of the metal in fusion tends to bring about the combination of the carbon and the iron, that is to say, the formation of white cast iron, which is undesirable. On the other hand, slow cooling tends to bring about the precipitation of the carbon producing a soft iron. The silicon assists to decrease the combined carbon, thus opposing hardness. The effect of manganese is opposite to that of silicon and is therefore undesirable. The effects of expansion and contraction are provided for by pre-heating every part of the object, or by any other treatment to bring about the same result.

White Cast Iron

White cast iron is made of metal of the same chemical composition as is used to make gray iron castings. The molten metal is cast in cold molds and is thereby "chilled." It is evident that no very great change in the chemical composition could take place in this chilling process. However, the sudden cooling arrests the formation of graphite to such an extent that the physicial properties of "chilled" iron are different from those of gray iron in which the normal structure exists. Chilled iron is hard and brittle. The white appearance of the fracture of the metal reveals its name, and is due to the comparatively small amount of free carbon present in the metal.

There are cases where it is desirable to have one surface of a casting very hard in order to resist wear,

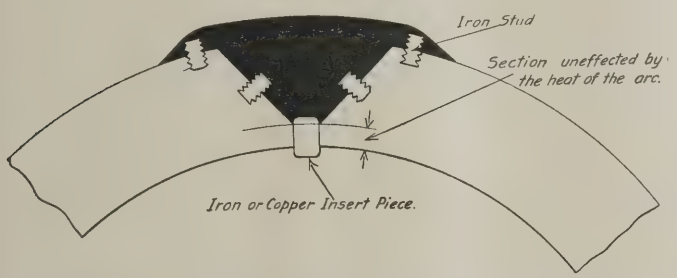


Fig. 3—Method of Welding Used to Avoid the Need of Machining Through the Heat Affected Zone

such as the tread of car wheels and the working face of anvils, etc. To do this it is only necessary to chill the surface so as to produce white cast iron to varying depths. There is little occasion for welding white cast iron and besides in most cases it is not commercially practical owing to the far reaching effect of the localized heat.

Malleable Cast Iron

Malleable cast iron has physical properties between gray iron and steel castings. Its tensile strength varies between 40,000 and 60,000 lb. per square inch with an elongation of 2½ to 5½ per cent in 2 in. Malleable castings are made by reheating white iron, packed in some material such as lime, etc., heated to a temperature roughly 840 deg. F. under its melting point. They are kept at this temperature for hours or days and under these conditions the combined carbon is freed in the form of powdered graphite, unlike the graphite in gray iron which is in the form of flakes. Since ferrite or free iron is soft and malleable the annealed casting partakes of these properties and is called a malleable casting. Annealed castthroughout the entire mass; as a rule, the annealing throughout the entire mass, as a rule the annealing does not produce a noticeable effect beyond a fraction of an inch below the surface of the casting.

Malleable cast iron is especially valuable and is used very largely for railroad work. At one time malleable cast iron was used extensively for couplers, but now steel castings are used. At the present time the indications are that gray iron is being replaced by malleable iron, while on the other hand malleable iron is being replaced by cast steel. Malleable iron is used extensively for parts of agricultural machinery and for many other purposes where it is especially adapted.

Welding of Malleable Iron

The correction of flaws in malleable castings by the arc process effects very large savings in the foundry. Such welding is always done after the casting is annealed and made into a malleable casting. Properly annealed castings will show just a thin skin of white iron on the outer edge. The annealed section is essentially low carbon cast steel.

The work may be welded with either the carbon or metallic electrode process. Due to the thinness of the annealed section a current as low as consistent for good fusion is used, in order to reduce the value of effective heat on the casting.

If the casting is to be machined in the welded section, it is reannealed. This is usually necessary owing to the fact that the heat of the arc will in effect reverse the annealing process. That is, the carbon which was set free as graphite by the annealing is dissolved in the iron again when the metal becomes molten in the heat of the arc. The carbon in combination with the iron makes the casting hard. In some cases such as the welding of heavy sections, the same methods as outlined for gray iron welding would also be required for malleable castings.

Until recently it has been a difficult matter to obtain a union between the added metal and the casting. This trouble, however, has been eliminated almost entirely by using a coated electrode for metallic arc welding. The extreme hardness and checks of the added metal, always present, at least in the first layer where a bare electrode is used, are eliminated also.

Wrought Iron

In the production of wrought iron the common practice is to place raw material such as scrap, pig iron, etc., in an open hearth furnace. Heat is then applied and as the metal becomes pasty the mass is continually raffled; slagging agents are introduced to purify and deoxidize the charge. After the metal has been raffled sufficiently the pasty mass is placed in what is known as a squeezer and as much of the slag as possible is squeezed out; some slag, however, always remains. The mechanical treatment consists of squeezing this slag out of the metal and rolling it into bars of a convenient shape, called "merchant bars." The quality of wrought iron is a function of its purity, e. i., its freedom from every substance except iron or ferrite. Norway and Swedish iron has been heretofore the purest iron ore which could be obtained in commercial quantities, due principally to the fact that the ore of these countries does not contain phosphorus

or sulphur. The traces of these impurities found in all American iron are sufficient to render it inferior in quality to the imported stock.

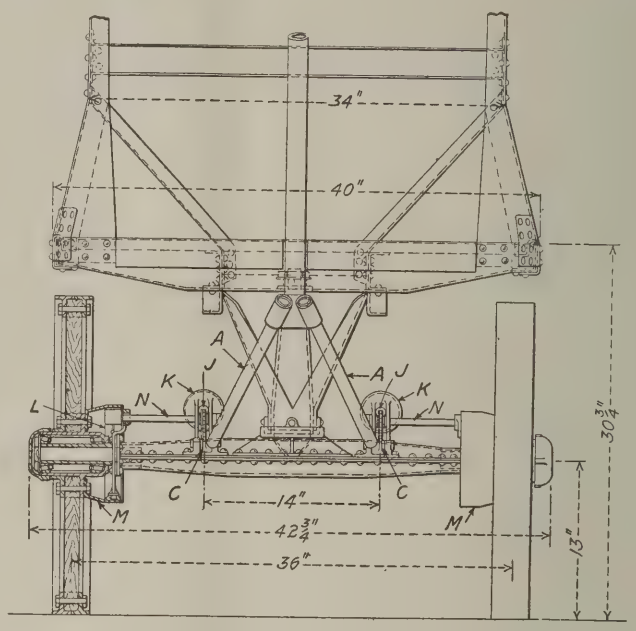
Wrought iron is used as a base in the manufacture of the highest quality of crucible steels, owing to its purity. The tensile strength of wrought iron is approximately 50,000 lb. per square inch. It is malleable and does not harden materially when it is subjected to sudden cooling.

The welding of wrought iron is safe and legitimate and good practice. No bad effects from the heat of the arc flame need be feared since the carbon is usually less than 0.12 per cent, which is not sufficient to give any hardening effect should the mass of the part be such as to cause sudden cooling. It should, however, be remembered that the metal added by the arc process is cast metal and has a lower degree of elasticity.

More concerning *Iron and Steel and Welding of Each* will appear in the next issue.

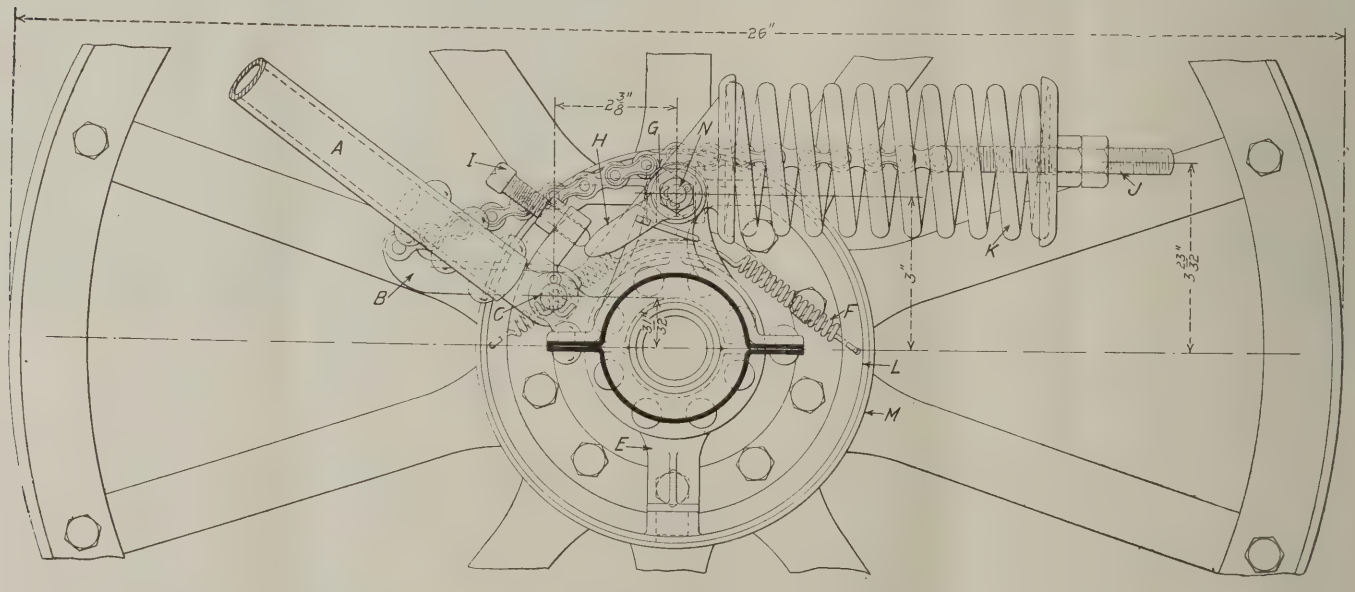
AUTOMATIC BRAKES FOR BAGGAGE TRUCKS

Electric trucks are practically all designed to "stay put" where the operator leaves them and this principle has been used by the Pennsylvania for hand trucks with very satisfactory results. There are a number of four-wheeled, hand-operated, baggage trucks in use at various points on the road which stop automatically wherever the user happens to let go of them. The advantages of such a truck are self-evident. It is not necessary to chain the wheels and the truck will not move when heavy pieces of baggage or express are placed or shifted on it. Also the danger of having a truck, left unchained, run into a moving train is eliminated.



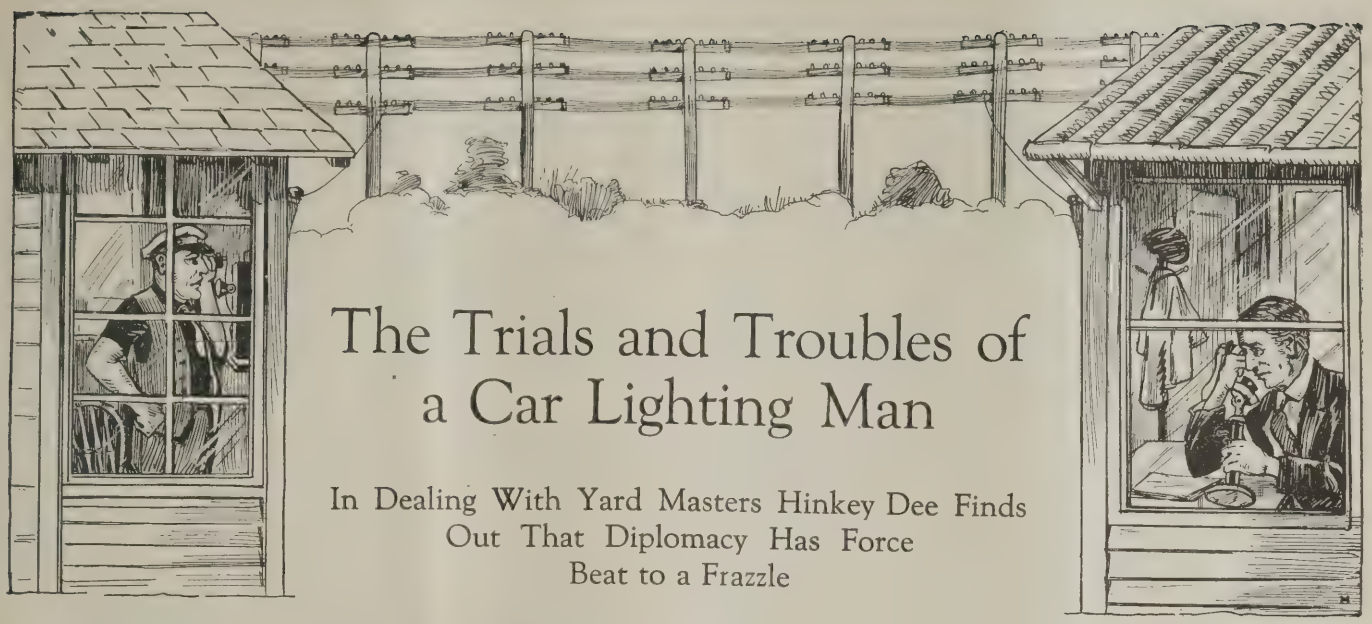
Front Elevation of Baggage Truck

In both of the illustrations similar parts bear the same letters. The two front wheels of the truck are equipped with band-brakes *M*. Two heavy coil springs, *K*, connected by chains to the handle through the member, *B*, hold the handle normally in a vertical position and keep pressure on the brakes. With the handle in the vertical position, the set screws *I* press on the arms *H*. This turns the shafts *N* and the cams *G* which press the brake bands *L* against the brake drums *M*. When the operator wishes to move the truck he pulls the handle down to a convenient position. This compresses springs *K* and moves the set screw *I* away from the arm *H*, which in turn allows the springs *F* to pull the brake bands *L* away from the drums *M*, leaving the truck free to move. The brake bands are secured to the members *E* and are divided at the top. When the operator lets go the handle it returns to the vertical position and again applies the brakes.



Side Elevation of Brake Mechanism

The value of this braking arrangement is manifested in stations where a few such trucks are used together with a large number of others not equipped with brakes. In stations so equipped there are a few trucks idle most of the time, but those equipped with brakes are never among the idle ones.



The Trials and Troubles of a Car Lighting Man

In Dealing With Yard Masters Hinkey Dee Finds Out That Diplomacy Has Force Beat to a Frazzle

ANYBODY who don't know nothin' about car lightin' thinks car lightin' electricians have a sinch but, believe me, I knows different. Yes, sir! I've been through the mill and you take it from me you have to go through the mill to get the inside dope on a car lightin' man's troubles. I've met a lot of car lightin' fellers but haven't met any one who knows as much as me. No indeed, they all seem to have a different idea and are afraid to talk. But be as it is, when it comes to loud talkin' I'm there! I don't care who knows it either, I don't care what I say, when I says it or who I says it to because I know all about car lightin' and I'm not afraid to tell it to anybody and I always tells the truth.

As I said before, it's a hard road to travel and no sinch to be an expert car lightin' man like me. Just figure how us fellers have to keep in right with, try to humor, and explain to these bonehead yard masters all we know about electricity over the 'phone in two minutes, it's no sinch. I says "two minutes" because everybody knows if you keep a yard master talkin' on the 'phone about electric light trouble on a car, more than two minutes his temperture gets so high he can't talk. Yes, sir, he's so used to yellin' "Hey, Oh, Bill—go in on five—pull 'em all but two—set three out on the ladder—put one back, then pick 'em all up and hold on to 'em," that he don't know how to concentrate long enough to absorb what an electrician has to say when he tries to tell him about a shopped car or somethin'. But you'll have to hand it to these yard masters because they're the boss and they're all full of knowledge to. Just imagine the studyin' a feller has to do and the brain he has to have to know enough to be a yard master. Yes, sir, a yard master is boss over everybody. The reason he's boss over everybody is because he knows all about everythin'. Why do you know that in order to be a yard master you have to have more degrees than anybody. That's the reason these yard masters have such long names, because each degree makes it longer.

First you have to have the degree of electrical engineer, then you has to have the degree of signal electrician, then you have to graduate as a car builder, elevator operator, wireless operator, steam engineer, brakeman, conductor, car inspector, seat turner, ice and water engineer, and I'm not sure but I think you has to work six months in the section gang also before you can get the degree of yard master.

To give you a little idea of the troubles of a car lightin' man I'll give you an exact copy of a telephone conversation between me and Pat O'Murphy, the yard master.

A car arrived with no lights and was to go out again in ten minutes, I called the yard master on the 'phone.

Yard Master.—"Hello, Wada yer want?"

Hinkey Dee.—"This is Hinkey Dee, the electrical expert."

Y. M.—"Go on! Go on! I don't care who yer are, wada you want, I ain't got all day to monkey wid yer."

H. D.—"Car No. 240 on No. 20 track is shopped for electric light trouble."

Y. M.—"Well, what's the matter with the car?"

H. D.—"It has no lights."

Y. M.—"Well, where are the lights?"

H. D.—"I don't know we are trying to find them."

Y. M.—"Well ain't yer got some more lights to put in the car?"

H. D.—"I don't want to put some more lights *in* the car, I want to get lights *on* the car."

Y. M.—"Now, young feller, don't yer talk to me that way, I'm the yard master and you'll do as I says if yer have more lights, put 'em in the car and be quick about it."

Bing! Down goes the receiver.

The car left in the train with no lights and returned next day with no lights. I called the yard master again.

Y. M.—"*We*—ll, wada yer want?"

H. D.—"Car 240 is in again with no lights and I would like to have the car cut out so we can work on it."

Y. M.—"No! No! No! I won't cut no car out, wada yer think it is anyway. Get on the job and do the best yer can."

H. D.—"Sorry, but we can't do the job if yer don't give us a chance to work on it."

Y. M.—"That car is goin' to go out on the run, it's got wheels on it, ain't it? Well it will have to go wid out any lights."

Finally next day Pat comes to the shop and wanted

some wire, sockets, switches, lamps and conduit, to wire his house for electric lights. I fixed him up and he said, "Thanks, Hinkey Dee."

'Phone conversation next day.

Y. M.—"Hello, wada you want?"

H. D.—"This is Hinkey Dee, the electrical expert."

Y. M.—"Oh, hello, Hinkey Dee, Old top, how are you today? What can I do for you?"

H. D.—"Why car 240 on 20 track is shopped for electric light trouble."

Y. M.—"All rite, Hinkey, Old boy! Old boy! Old boy! Leave it to me. We'll cut that car out rite away, all rite! All rite! All rite! And let yer know where we put it. Old boy! Old boy! Old boy!"

H. D.—"Much obliged."

Y. M.—"Yer welcome, Hinkey, call us up any old time we'll be glad to help yer out anyway we can Old top!"

Now can you beat that! Can't you see now that to be an expert car lightin' electrician on a railroad you not only have to be good electrically, but youse has to be a diplomat also. You may be a good electrician and know all about car lightin' like me, but if you don't know how to get these yard masters to tell the truth and place cars for chargin' and repairs without usin' force you might just as well do as Jess Willard did on July 4, and throw up the sponge, cause you can't get yard masters to do anythin' by force.

One time I shopped a car for generator repairs, the armature and field coils were burned up. I shopped the car on Monday, eight o'clock in the mornin' and asked the yard master to please place the car on the shop track so we could work on the generator. The car was placed on a storage track in a freight yard sixteen miles from the battery house and was not placed on the shop track so's we could work on it for twenty-two days. Then they placed it on the shop track at nine o'clock in the mornin'. At nine-thirty, just thirty minutes later, the yard master 'phoned and asked if the car was o. k. I told him we had just started and that we had six hours good solid work on the car. He said he was goin' to take the car and use it at ten o'clock just thirty minutes later, no matter if it was finished or not. And he did! We had the generator half off and half on when he took the car away and placed it in service. After the car was on the road about 10 minutes the generator fell off. The passengers got terribly scared. Finally the train jumped the track and run square into the yard master's house. Lucky no one was home for the cars smashed in the front of his house and plowed right through.

When the yard master got home from work and found his house all caved in, gosh, he got mad! The conductor told him it was caused by the generator fallin' off that car he took away from Hinkey Dee.

Then he wrote me up and a committee of eight after a long conference decided that the yard master was right and I was suspended ten weeks for not havin' the car fixed when the yard master wanted it, and the yard master was promoted for bein' good and gettin' the trains out quickly even if they weren't safe to run.

That learned me a lesson. From that time on me and Jimmy Goat get the cars finished when the yard master wants 'em, no matter how long it takes.

There are things you have to give yard masters credit for though and that is no matter how many cars you shop to 'em they don't have to write 'em down. No, sir, they can remember the number of every car without writin' it down and they never make any mistakes. If you don't believe me ask a yard master some day if he ever makes any mistakes and see what he says.

And not only that, they're good at arithmetic too. How I come to find it out was one day Jerry Fizz, the head yard master, asked me what the voltage was on a car when it was full. I said, "Thirty volts." Now says he, "Just how long will the car last when its full." Then I says, says I, "Just fifteen hours." Says he, "Is that so? 30 volts last 15 hours, then one volt will last 1/30 of 15 hours or ½ hour and if one volt lasts

Finally the Train Jumped the Track and Run Square Into the Yard Master's House

½ hour, two volts will last 2 times ½ hour or one hour. Therefore, if a car tests two volts it will last one hour." Talk about wisdom in abundance. These yard masters sure do know somethin' when it comes to volts. Then he says, says he, "Two volts last one hour, seven days one week, 24 hours one day, 24 x 7 x 2 equals 196. Say, Hinkey, why don't they make 'em 196 volts then they'd last a week." I told him you could do that but where would you get the amperes. Jimmy Goat said "Maybe you could get some from the ohms." So I says, says I, to the yard master, "I'll have to ask the boss and let you know."

The Wireless Operator in the steamer Karoola has reported that when his ship was off the northwest coast of Australia he received clear messages from an English low power station in the North Sea which were transmitted on the ordinary short wave-length of 600 meters.

This feat was achieved with the new Expanse type magnifying valve receiver designed and manufactured in Sydney, Australia, by Amalgamated Wireless (Australasia) Limited. These receivers include a modified Fleming valve and were originally designed by the company's managing director, E. T. Fish, for demonstrating the possibility of receiving messages in Australia direct from the Marconi station at Carnarvon in Wales, nearly 12,000 miles away, or practically half way around the globe.

Railroad Electrification Facts and Factors

Details of Controlling Apparatus and Construction of Electro-Pneumatic Unit Switches

By A. J. Manson*

IN the preceding articles we have traced the electric current from the third rail shoes to the main switch in the case of the direct current locomotive, and from the overhead trolley, through the pantagraph, the high-tension circuit breaker and the transformer, in the case of the alternating-current locomotive. Apparatus is necessary to connect the electric current to the motors and to provide a means for connecting the motors in the proper combinations for operation forward and backward at different speeds. This apparatus is designated as control apparatus.

Two distinct systems have been used to date, namely,

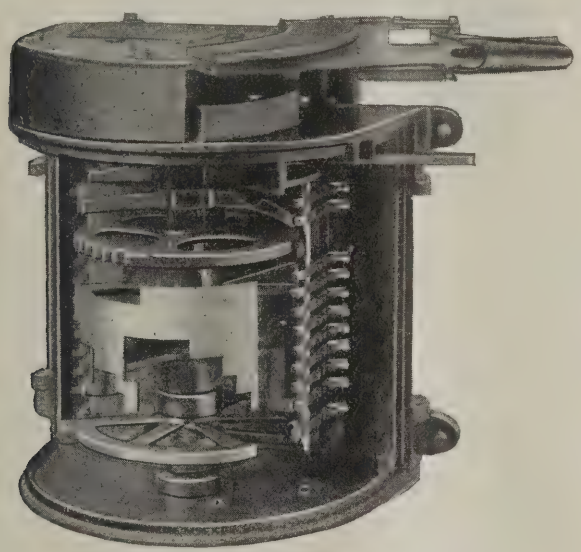


Fig. 1—Master Controller—Electro-Pneumatic System

the electro-pneumatic system and the electro-magnetic system. The electro-pneumatic system has become the universal system. As the name implies, air pressure, which is available on the locomotive, is used to close the switches. The air pressure to and the exhaust from the various switch cylinders is regulated by small magnetic valves which are remotely controlled. These circuits are called the "control circuits," and power to them is usually supplied from a storage battery of from 22 to 32 volts. The general arrangement is as follows: The battery power is connected to the master controller, which corresponds to the engineer's throttle on the steam locomotive. This master controller is located adjacent to the air brake valve and provides the means for connecting the battery current to a system of control wires which run from the master controller to the unit switches. The energizing of one of the control wires operates a small air valve, allowing the air pressure to enter a cylinder, moving the piston, and thereby closing the switch. The power from the main circuit is connected to the switch, which upon closing throws the power on the motors.

*Westinghouse Electric & Manufacturing Company, New York.

The electro-magnetic system does not make use of the available air pressure for closing the switches, but depends on the electric power. The power for closing the contacts or switches is obtained from the magnetic pull of a solenoid through which is flowing an electric current of small value. The arrangement of the control circuits in this system is somewhat the same as in the electro-pneumatic system, except that high voltage of 600 volts is used instead of a low voltage from a battery. There are systems using higher voltages than 600 on the third rail or overhead wire, namely, 1,200, 2,400 and 3,000 volts, but in each case provision is made to reduce this voltage to approximately 600 volts for the control circuits. A tap is made to the main supply, if of 600 volts, and connected to the master controller. The master controller is composed of fingers and a drum, and as the drum is rotated the power is connected to the wires leading to the solenoids in the switches. The master controller is slightly different from the one used with the electro-pneumatic system shown in Fig. 1, as it handles larger current per finger and a higher voltage. The creepage distances must be greater and the fingers larger. Moreover, blow-out coils are necessary at the finger con-

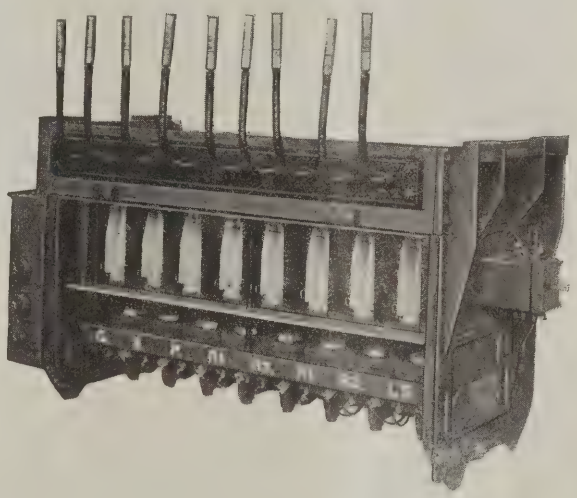


Fig. 2—Front View of a Switch Group of 8 Switches

tacts to disrupt the arc which occurs in opening of the solenoid circuit, which are not required in the electro-pneumatic system on account of the low voltage. The flow of current through the wire coil, or solenoid, creates a magnetic field and the pull of this field is applied to operate and close the switch by means of a plunger connected to the movable jaw of the switch and extending into the core of the solenoid.

We will first consider the design and construction of one of the electro-pneumatic switches. The switches are grouped together in numbers varying anywhere from 6 to 12, or even more. A group of switches is called a

switch group. An arrangement of this kind is most convenient. Each switch is a unit and is interchangeable with any other switch. Moreover, by grouping the switches many connections between switches can be made by permanent copper straps and only the necessary number of leads leave the group for connection to other groups or to the motors. Such a group of switches is shown by Figs. 2 and 3. The strap connections are shown clearly in Fig. 3, connecting one stud to the other in the proper sequence. To understand the operation and construction of one of these unit switches a cross sectional view is shown by Fig. 4 and a cross sectioned drawing by Figs. 5 and 6.

The air is piped into the end of the group at 70 pounds pressure and fills the pipe reservoir running the whole length of the group. Each of the cylinders and magnetic valves receive air from this reservoir through the air nipple *AA*. Gaskets *BB* are used to prevent leakage of air. The 70 pounds of air pressure is therefore always available around the head of the lower valve *V* which is held on its seat by the spring *U*. When the engineer operates the master controller, thereby connecting the

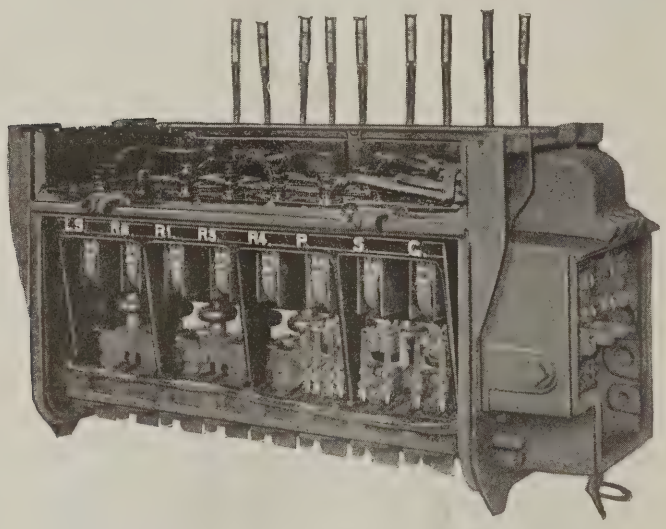


Fig. 3—Rear View of Switch Group Shown in Fig. 2

battery voltage to a control wire, the battery current flows through the wire to the terminal *NN*, through the magnet coil and out of the other terminal (not shown) back to the battery. The battery current flowing through this coil magnetizes the core, so that the armature *R* is drawn down. As shown in the cross section, the armature *R* rests on top of the upper valve stem *S*, so that when the armature is drawn down, the upper valve stem pushes the lower valve *V* away from its seat. Seventy pounds of air pressure can then pass up through the opening into the passageway leading into the cylinder. The air pressure entering the cylinder compresses the heavy spring and pushes up the piston rod forcing the switch contacts together and establishing the main circuit connection.

The switch will stay in as long as the magnet is energized and there is sufficient air pressure to compress the spring. When the battery voltage is disconnected from the control wire the coil is no longer energized, there is no pull on the armature and the lower or inlet valve closes on its seat due to pressure of the small spring *U*. Air pressure is thereby cut off from the passageway leading to cylinder. It should be noted that the lower end of the upper valve stem *S* forms a valve and when pushed down by the armature closes the opening from the passageway to the exhaust port. This is the exhaust valve seat, so that when the coil is energized and air pressure is admitted to the cylinder, it is retained in the

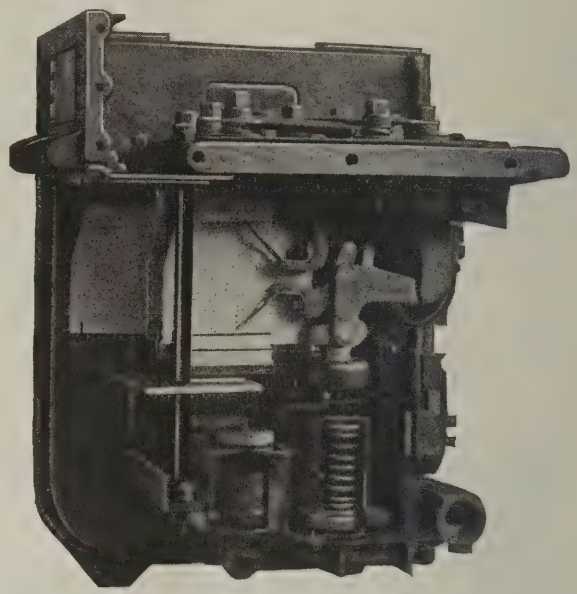


Fig. 4—Cross Sectional View of the Unit Switch

cylinder, and when the battery voltage is disconnected from the coil and the valve stem returns to its normal position the air in the cylinder can pass out to the atmosphere through the exhaust port. The air is expelled

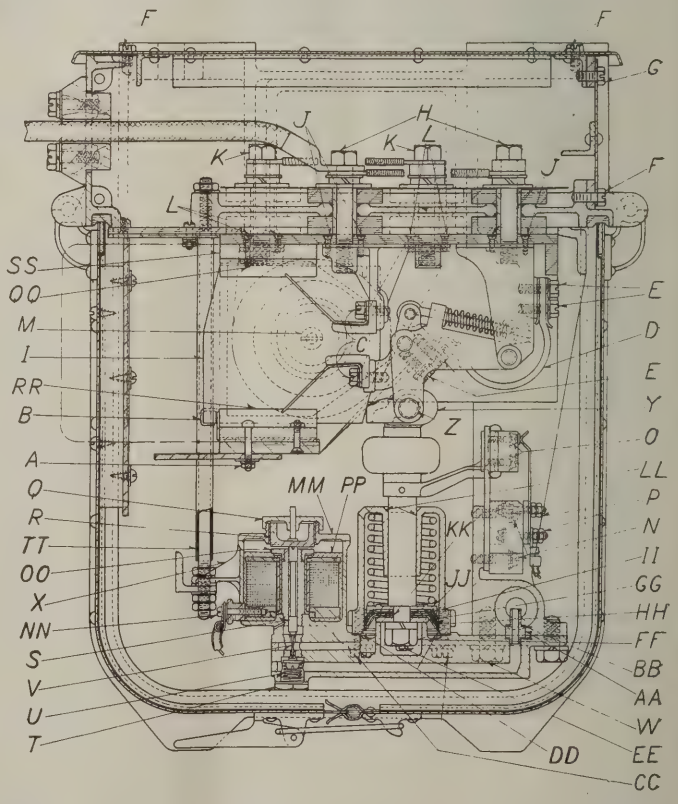


Fig. 5—Cross Section of Unit Switch—Electro-Pneumatic System

by means of the heavy spring in the cylinder and the main contacts are opened rapidly.

The design and construction of the packing used in

the cylinder to prevent "blowing" by pressure of the air is interesting. The packing *II* consists of triple leathers, each leather being specially treated and specially formed to cup shape. The packing is backed up by a steel follower *GG*, also cup shaped and an expander *HH* is used on top of the packing so as to keep the leathers in the correct shape and against the cylinder wall.

The cables leading from the motors and resistance connect to the stud bolts *H*. These studs pass through the top framework of the switch group, being insulated therefrom by means of washers and a tube made of insulating material. The studs screw into the copper cast-

List of Parts Shown in Fig. 5

A	Bolt holding bottom arc chute.
B	Spring holding arc chute sides.
C	Bolts holding switch contacts.
D	Copper braided shunt.
E	Bolts holding copper braid shunt.
F	Screws holding covers (top and side).
G	Screws holding (side).
H	Bolts holding switch and forming terminals.
I	Arc chute side.
J	Screws holding switch part to box.
K	Bolts holding blowout coil and forming terminals.
L	Screws holding blowout coil to box.
M	Screw holding pole piece on blowout coil.
N	Screws holding interlock finger base.
O	Screws holding moving block of interlock.
P	Bolts holding interlock fingers.
Q	Magnet valve cap.
R	Armature of magnet valve.
S	Valve stem.
T	Plug holding lower valve stem and spring in position.
U	Valve spring.
V	Lower valve stem.
W	Bolts holding cylinder and magnet bracket in position.
X	Foot-supporting front end of magnet bracket.
Y	Hooked end of air cylinder piston rod.
Z	Pin on switch part which engages in hook Y.
AA	Brass air connection bushing.
BB	Gaskets for air connection bushing.
CC	Bolts holding cylinder in position.
DD	Gasket for air cylinder.
EE	Cotter pin to prevent nut FF from slacking off.
FF	Nut holding piston details in position.
GG	Piston follower.
HH	Expander.
II	Triple packing.
JJ	Piston.
KK	Point where triple packing fits piston rod.
LL	Piston rod guide.
MM	Iron cover of valve magnet.
NN	Terminal of magnet coil.
OO	Magnet core cap.
PP	Sealing material (asbestos tape painted).
QQ	Bolt holding arc chute.
RR	Bottom arc chute.
SS	Top arc chute.
TT	Insulated bolt holding angle iron which supports front end of valve magnet casting.

ings one of which is stationary and to which is bolted a copper contact, while the other is composed of a movable arm to which is bolted the other contact. The main current, as can be seen, enters and leaves the top of the group while the main circuits are entirely independent of the control circuits. The end of the piston rod carries an insulator, in order to insulate the power voltage from the control apparatus. The hook Y on the upper end of the piston rod engages with the movable arm and thus closes and opens the main contacts. The bolts *C*, used for bolting the contact tips in place also hold in position strips of copper which project beyond the contact points. These strips are known as arcing horns. As the name suggests they are used to take care of the arc which forms when the contacts open breaking the main circuit current. The arc which is formed across the tips of the contact is carried out along the arcing horns, becoming of greater and greater length, and when it reaches the end of these horns it is blown out and the circuit is interrupted. To aid in the rapid disrupting of

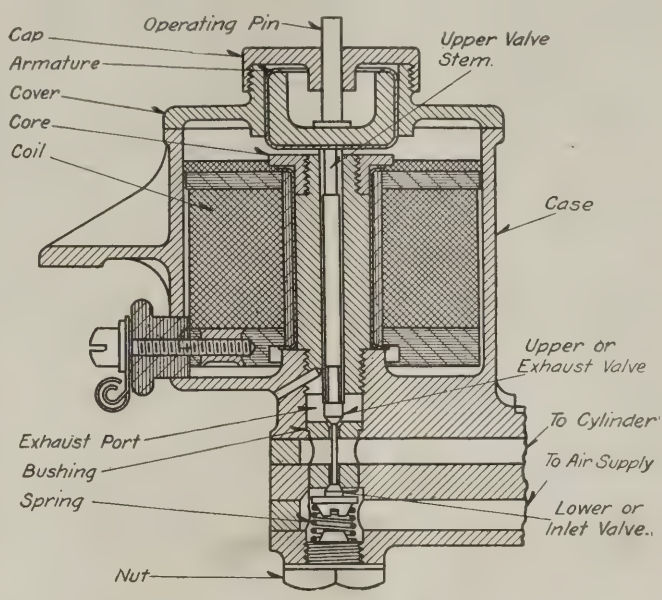


Fig. 6—Cross Section of the Magnet Valve

the arc blowout coils are used. Referring to Fig. 2 and 3, it will be noted that there are spaces between each of the switches. This space is not vacant, but is occupied by a blowout coil, details of which are shown by Fig. 7. The blowout coil consists of a few turns of copper strap and the connection to it is made by the studs as shown. The arrangement of main circuits is such that the current flows through these blowout coils before it passes through the switches. With this arrangement the contacts open

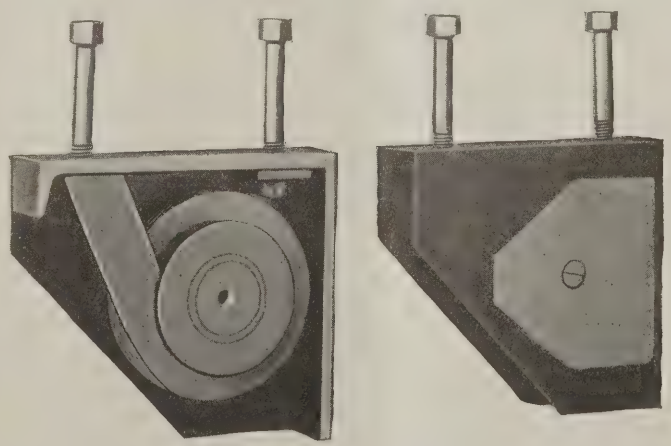


Fig. 7—Blow-out Coil

and an arc is formed, with the current still passing through the blowout coils. A magnetic field exists across and at right angles to the arc between the contacts, so that according to the laws of magnetism and electricity the arc must move in the magnetic field. The arc is

blown out magnetically, the time taken being almost instantaneous.

Naturally, considerable heat is formed with repeated opening of a pair of contacts and the arc is confined in an arc chute having removable sides which are shown in Fig. 2 and by *I* in Fig. 5. To carry the current from the movable contact around the point of support, to eliminate heating, a copper braided shunt *D* is provided which bolts directly to the copper casting and the contact block. The construction of the movable arm is such, that as the contacts are pressed together there is a wiping action to insure of good contact.

THE CARE AND USE OF ELECTRIC HOISTS*

The electric hoist is a piece of machinery requiring the same care and attention as any part of a power equipment.

Clean, dry places of installation give the best results, but as these are not always available special care and attention must be given where acid fumes, dirt, grease and high temperatures are present.

While electric hoists may be used out-of-doors without injury, it is advisable to provide a shelter for protection while not in use.

Regular inspection and replenishing lubricants will prevent damage and prolong the life of the hoist.

Connections

The National Board of Fire Underwriters requires that main feed wires be protected by fuses or a circuit-breaker and controlled by a switch. These are preferably located as near as possible to the hoist and in plain sight.

If a mono-rail track is used it must be permanently and effectually grounded.

A connection diagram is attached to the inside of the controller cover of each hoist, showing all electrical connections and the resistance values where resistance is used. Line circuit-breakers should be set, or fuses used, about double the full load current marked on the motor name-plate of the hoist, except where special conditions reqire a variation from this rule.

Lubrication

High-grade oil or grease must be used for all bearings or totally enclosed gears to obtain maximum wear. See manufacturers' specific instructions for lubrication and lubricant.

Oil should be drawn off bearings occasionally and renewed, to remove dirt and grit from oil wells. Gear housings require this about every six months.

Grease cup bearings should have the cups filled and the top of the cup screwed down hard against the grease to keep it feeding. Vaseline should not be used as its melting temperature is low and will not give good results. The refilling of cups should be carefully followed up, the frequency depending on the service imposed.

Should a bearing run hot the following may be the cause: Oil ring type—low-grade oil, grit, clogged oil grooves, insufficient oil. Grease cup type—clogged feed duct, lack of pressure on grease. Worn or cut bearing. Bent shaft.

The bearing of A. C. hoist motors must be given special attention as the air gap between the rotor or rotating part, and the stator or stationary part is very small in motors of this class. Wear in the bearings will cause the two parts to rub and damage the windings. The air gap or space between these two parts should be examined frequently and if there is danger of rubbing, the bearings must be replaced or the windings will be burned out.

Dust and grit must not be allowed to accumulate in the windings or around the bearings. Clean the motor thoroughly at regular intervals and blow the dust from all parts.

Care of Direct Current Motors

While the motors furnished with the hoists are of especially rugged and substantial build, it is necessary that they receive systematic inspection, and the usual attention given electrical machinery.

The collection of dust, or a mixture of oil and dust on any surface in the motor affords a path for the electric current to leak across.

Motors should, therefore, be inspected once a week by removing the commutator covers, and the interior blown or wiped out.

The commutator should be wiped off occasionally with a slightly oily rag, but care should be taken that not too much oil be used, as this has a tendency to work into the mica between the bars and carbonize.

The brush-holders automatically regulate the tension of the brushes, and should not be changed.

If the surface of the commutator has a raw copper color and gradually roughens it should be smoothed off with fine sand paper by running the motor and holding the sand paper against the commutator with a wood block. *Never use emery.*

The ideal appearance of a commutator is a polished dark brown color and when in this condition and slowly rotated the brushes will squeak sharply.

When making proper contact with the commutator, the face of the brush is glazed over the entire surface. To obtain this full contact of the brush use a strip of sand paper drawn between the commutator and brush. The commutator surface should be wiped clean after doing this.

Motor Trouble

The following conditions will cause sparking at the commutator:

1. Excessive overload.
2. Improper brush holder adjustment.
3. Poor brush contact caused by:

(a) Accumulation of grease or dirt which may prevent the brushes from touching the face of the commutator.

(b) Brushes may need grinding to fit the commutator.

(c) Brushes may stick in the holder. This sticking may be overcome by cleaning with gasoline, then if the sticking still persists, scrape or sand paper. Scrape or sand paper them until the movement is free, but be careful not to make the brushes fit too closely in the holder as in this case they will spark heavily.

(d) Brush worn out and too short.

4. Rough commutator.

*Extract from a paper published by the Electric Hoist Manufacturers' Association, 9 East 40th Street, New York, N. Y.

5. Poor connection between the brushes and the holder.

6. Loose connections of the armature leads to the commutator bars, indicated by the blackening and burning of the adjacent bars. An open circuit anywhere in the armature will cause sparking that seems to encircle the commutator when running and will burn the bars to which the open circuit coil is connected.

7. Short circuited armature coils are indicated by heavy intermittent sparking, burned commutator bars and excessive local heating of the armature. This can readily be found by stopping the machine after it has been running continuously for a while and feeling its surface.

8. Short circuited coils might exist which would not be indicated by sparking, but might be indicated by irregularity in speed.

Alternating Current Motors

Failure to start may be due to low voltage. Since the torque of the induction motor is proportional to the square of the applied voltage, a reduction of this voltage has a great effect upon the starting torque. To test this a voltmeter reading is taken at the instant the controller switch is closed. The reading must be taken this way as it is possible for the voltage to be right when the hoist is not operating.

If the generator, transformers or transmission lines are too small the heavy starting current will reduce the voltage so that the motor will not have torque enough to start under load.

A short circuited coil in the stator or stationary part of the motor will cause it to buzz and hum and the winding will overheat and smoke if the controller is held in the running position.

Spare Armature Or Rotor

Clean oiled burlap should be wrapped around the shaft if the armature is out of the hoist to remain out of service for any length of time. This prevents rust.

When inserting a shaft into ring oiled bearings, the rings should be lifted to prevent injury.

Controllers

To reverse the running direction of the hoist, the controller should be allowed to return to the off position and not moved to the reverse position until the motor has come to a stop. The hoist will then stop if the brakes are properly adjusted. The hoist may then be started in the desired direction without unnecessary electrical or mechanical strain.

To get the best service from the hoist, avoid unnecessary starting and stopping or quick reversals.

The controllers should be inspected weekly to see that the contact plates and fingers are free from bugs or abrasion, and roughness removed by means of a file or sand paper, and the contact plates lubricated with a very small amount of vaseline. *Do not use too much vaseline on controller fingers or plates.* The controller should also be tried with the current off to see if the fingers have the proper lift. The lift of the fingers should be from 1/16 in. to 3/32 in.

Ropes

The ropes should be kept well lubricated with heavy oil or cable lubricant which will increase the life of the rope, preventing rust and abrasion. Care should be taken in lowering that the drum does not continue to turn after the hook is stopped by or rests on anything, as such action might allow the rope to spring out of the grooves in the drum and so cause it to become cut or bruised when the next load is put on it unless it be noticed and put in place.

The hoist should be directly over the load when used.

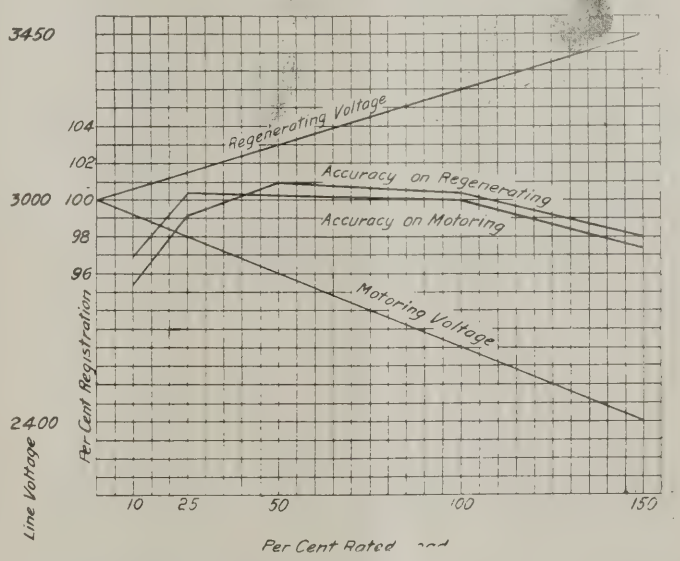
When unpacking a new rope, it must be unwound as from a reel and great care exercised not to kink or twist it. If a rope is allowed to form a loop and then draw straight, a kink will result, thus leaving a permanently damaged and weakened spot even though the rope is afterwards straightened.

When the hoisting rope is changed the automatic stop must be reset.

Where a lever type of limit is used, no resetting is necessary.

DUPLEX DIAL WATTHOUR METER FOR ELECTRIC LOCOMOTIVES USING REGENERATIVE BRAKING

Ten new locomotives for the electrified divisions of the Chicago, Milwaukee & St. Paul are being equipped with Economy duplex dial watt-hour meters which will measure accurately the energy consumed in driving the trains and that returned to the line through regenerative braking, each reading being shown on one of the two cyclometer type dials. The locomotives are of the Baldwin-Westinghouse passenger type. Each is equipped with six 533-h. p. twin-arma-



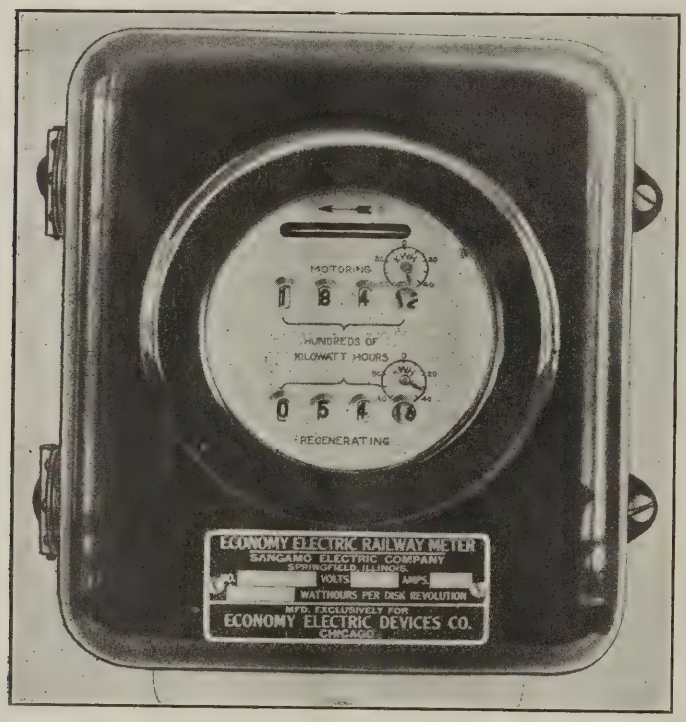
Curves Showing Accuracy of Meter Registration Under Severe Operating Conditions

ture motors, and one "Sangamo Economy" railway meter. These meters are a modification of the single dial type which is ordinarily used on street car and interurban systems. They are manufactured by the Sangamo Electric Company, Springfield, Ill., and sold by the Economy Electric Devices Company, Chicago.

The Chicago, Milwaukee & St. Paul uses watt-hour meters on its electric locomotives for three main reasons: 1. Because certain accounting charges are distributed on the basis of the watt-hour consumption

required by electric locomotives for the respective classes of train service. 2. To check the economical use of power in connection with the handling of the train. 3. To provide certain operating and engineering data in order to check the economical and satisfactory operation of the electrification system as a whole.

The electric locomotives in use at present are equipped with watt-hour meters, which give the net power used for any run; that is, the regenerated reading is subtracted from the motored reading, but in order to get the approximate values of motored and regenerated energies respectively, it is necessary to read the meters at certain points on the road between which the general use of power is either on the motoring side or the regenerating side. The Economy duplex-dial meters, however, make separate records of the motoring and regenerated energy, so that readings of the meter are required only at the beginning



The Economy Watt-hour Meter Showing the Dials for Recording Power Used in Motoring and Power Developed by Regeneration

and end of a run, and the results will be exact instead of approximate.

The wide voltage and load conditions under which these meters must operate can be appreciated from the fact that the voltage varies from an average of 2,600 volts on motoring to an average of 3,300 volts on regeneration. The success which the meter is expected to give in meeting these conditions is indicated in the illustration showing the accuracy curves of the meter. From these curves it will be seen that there is a variation of less than ½ of 1 per cent in the accuracy of registration between motoring and regeneration from 25 per cent to 150 per cent of the rated load and over a potential variation from 2,400 volts to 3,450 volts.

This desirable accuracy characteristic has been achieved through the use of the standard Sangamo D-5 mercury flotation 10-ampere meter element with special series compounding. Each meter has an external shunt of 800 amperes normal capacity, capable of high overload service. The meter element has a series compound winding around the shunt field. This compound-winding is reversed from normal practice and therefore acts as a bucking compound winding when the locomotive is motoring and as a boosting compound winding on regenerating. This winding is a part of the current circuit carrying the full-load current of the meter element which is 10 amperes, diverted by the 800-ampere open type shunt which is cut in on the negative side of the motor group.

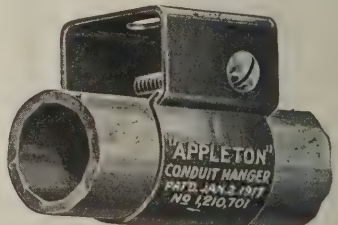
In mechanical design these duplex-dial locomotive meters differ from the regular Economy meters used in electric railway power-saving work only in the dials and gear trains. The dial is of the duplex type with openings for two sets of figures as shown in the illustration. The reading for the motoring is above and for regenerating below, so that a subtraction can easily be made to get the actual net energy used for any period. The single meter element drives the two gear trains through a differential which is arranged in such a way that when the locomotive is motoring, the energy drawn from the trolley is registered on the upper train and when it is regenerating the energy is recorded on the lower train. The reversal is made without loss of motion in the gear train.

In the design of this meter standardized parts are used. The meter element is so mounted on a sub-base that it may be removed from the case with little effort and without disturbing any heavy circuits. The case which protects the element is of heavy construction with tight-fitting joints designed to exclude dust. These meters, without their shunts, may be checked easily as 10-ampere units.

CONDUIT CLAMPS AND HANGERS

One screw conduit clamps made from steel, light in weight and substantial are being manufactured by the Appleton Electric Company of Chicago, Ill. As shown in the illustration, only one screw or bolt is required to fasten the clamp and hold it securely to the conduit.

Conduit Clamp



Conduit Hanger

The sharp edges on that part of the clamp which fits over the conduit serve to hold the conduit very rigid.

The conduit hanger, illustrated herewith, consists of two parts, a base and clip. The clip is fastened on over the conduit, slipped into the base, after which the screw on the side is tightened and a firm grip made on the conduit. These hangers are light in weight, very durable and add greatly to the appearance of the installation on which they are used.

What One Should Know About Power Factor*

An Explanation of Difference Between Direct and Alternating Current, Including Study of Inductance

A BRIEF analysis of the phenomena attending the use of alternating currents for power transmission, and their comparison with those attending the use of direct currents will be instructive and perhaps valuable. The characteristic difference between direct-current power and alternating-current power, is the so-called "power factor" attending alternating-current power transmission.

As is well known, in direct-current engineering, when a pressure is applied to any device having electrical resistance, the power effect is represented by the product of the applied pressure and the direct-current it produces in the given device or apparatus. In other words in such application the product of *volts* by *amperes* gives the power delivered in *watts*.

If the power apparatus consists of a motor, and an alternating pressure is applied to it, the delivered power is not correctly represented by the product of volts and amperes directly; the product must be modified by multiplying it by another factor, which is called the "power factor." It is the effect of this factor or coefficient, not only on operative efficiency, but on facility of performance as well that needs consideration.

The operation of any electric power system consists of three distinctive features: generation, transmission and utilization. Since power factor attends all three in alternating current application it will be well first to consider power factor in a general way and then make specific and concrete practical applications.

Consider first a length of No. 18 gage copper magnet-wire, 1,500 ft. long. A copper wire of this size and length will have a resistance of very nearly 10 ohms. Now if this wire is laid out straight and a direct pressure of 110 volts is applied to its terminals, as indicated in Fig. 1, a current of 11 amperes will flow through it.

If while in this same straight condition an alternating pressure is applied to the wire, an alternating current will be produced in the straight wire having exactly the same numerical value as that of the direct current. The alternating power in such a case will be exactly the same numerically as the direct-current power. But if the cotton insulated magnet wire be wound into a coil consisting of say 3,000 turns and the same alternating pressure applied to the terminals of the coil, as indicated by Fig. 2, the alternating current will now be very much less than when the wire was straight; while the application of the direct pressure will produce exactly the same current as it did originally.

When the direct pressure is applied to the coil terminals, the applied pressure multiplied by the current it produces, represents the power effect; while the alternating power effect is very much less. The coiling of a wire produces a "choking effect" so far as the production of alternating currents is concerned, or acts as so much additional resistance would in the case of a direct current. The determining of this result is simply a matter of experiment. For example, a certain voltmeter and ammeter may be connected with the straight wire as indicated in Fig. 1. and 110 volts applied to the terminals of the arrangement as indicated. The ammeter will, if correct, indicate 11 amperes, for either direct or alternating pressure, and the actual power in each case will be 1,210 watts.

If now the wire be coiled into a coil about 8 in. long with a 2 in. diameter central hole, and an alternating pressure of 110 volts at 60 cycles be applied to the terminals, the alternating current in the coil will be about 2 amperes, while a direct pressure of 110 volts applied to the terminals of the coil will produce as originally a direct current of 11 amperes.

The ohmic resistance of the coiled wire is 10 ohms, exactly the same as before it was wound into a coil, so that the choking effect for alternating currents must be due to some agency other than resistance. The only other possible agency must be a counter electromotive force; that is, an induced alternating pressure that acts in opposition to the applied alternating pressure. Since such a counter pressure must be an *induced* pressure, it is called the counter electromotive force of induction, and the measure of the induced effect is commonly known as inductance. The effect of inductance is indicated by the symbol L and the unit of inductance is called the *henry*.

The current in a coil, due to the application of an alternating pressure, is not correctly expressed by Ohm's law as in direct-current engineering, but by what may perhaps be considered a modification of Ohm's law. The alternating current in any coil may be expressed by the following general expression

$$I = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}}$$

in which I denotes the alternating current, in amperes, E denotes the applied or impressed alternating pressure, in volts, R denotes the ohmic resistance of the wire constituting the coil (10 ohms for the coil just mentioned), L denotes the so-called coefficient of inductance, expressed in henrys, f denotes the frequency in cycles per second of the applied alternating pressure, and likewise of the resulting alternating current, and π has the usual value 3.1416.

While no indicating instrument can directly indicate the numerical value of L, the value may quite easily be obtained by experiment. Suppose a coil is connected with an alternating circuit, with a voltmeter, an ammeter and a frequency meter as indicated in Fig. 3. With the alternating pressure applied, the numerical values of I, E and f are indicated respectively by the ammeter, voltmeter, and frequency meter. Since the numerical value of the resistance R is known, the only unknown quantity represented by the symbols in the given equation is the

*An abstract of an article by Prof. F. E. Austin, Thayer School of Civil Engineering, Dartmouth College, as published in the Scientific American Supplement, No. 2,263, May 17, 1919.

coefficient of inductance L. The equation may be solved for L and expressed as follows:

$$L = \frac{\sqrt{E^2 - I^2R^2}}{2\pi fI}$$

Assuming the numerical values already mentioned to obtain for a coil as represented in Fig. 3, that is $E = 110$ volts, $R = 10$ ohms, $I = 2$ amperes, $f = 60$ cycles, then the numerical value of L will be

$$L = \frac{\sqrt{12100 - 400}}{(377)\ (2)} = \frac{\sqrt{11700}}{754} = \frac{108.1}{754} = 0.14 \text{ henry}$$

It is evident from the last calculation that even one henry will act to reduce very greatly the numerical value of the alternating current in any circuit.

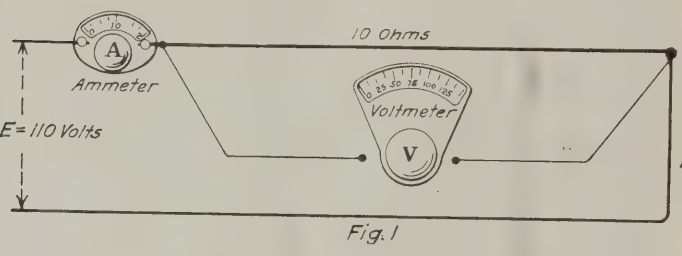


Fig. 1

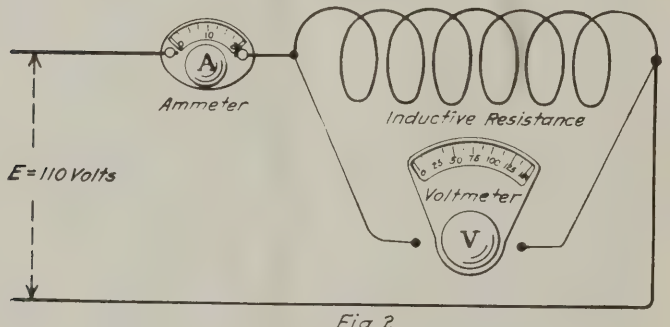


Fig. 2

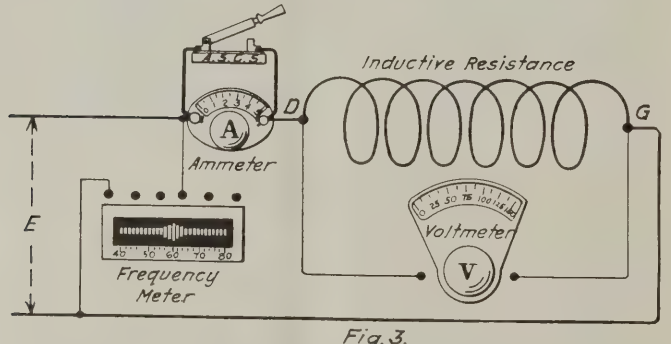


Fig. 3.

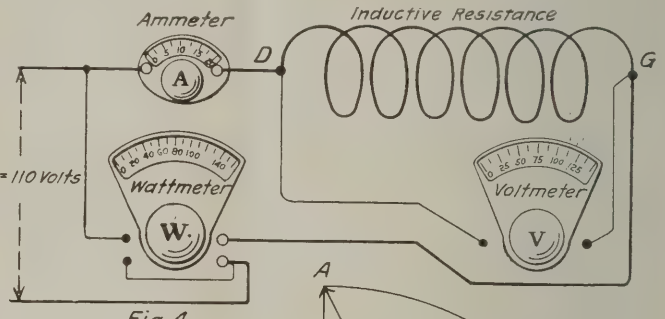


Fig. 4.

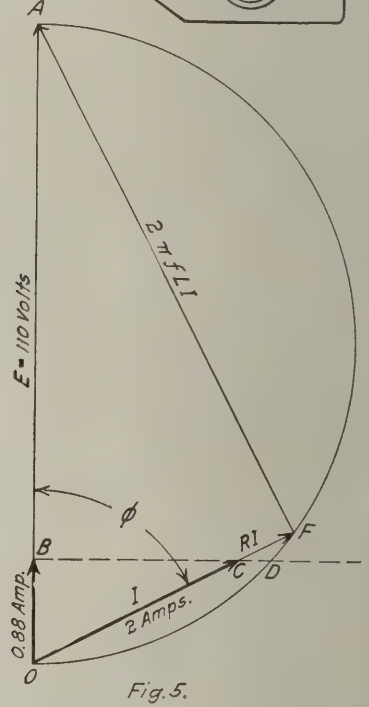


Fig. 5.

The next interesting consideration is that of the alternating current power. If the applied alternating pressure is 110 volts and the resulting current is 2 amperes, the resulting power cannot be greater than $110 \times 2 = 220$ watts. In order to increase this alternating-current power to 1210 watts which an applied direct pressure of 110 volts would produce, the applied alternating pressure at a frequency of 60 cycles, will need to be increased to over 605 volts. While a direct-current series motor will operate on an alternating-current circuit, the alternating pressure applied to the motor will need be very much greater than a direct-current pressure, in order to give the same output.

It has been stated that in an alternating current circuit as shown in Fig. 3, the power in watts cannot be greater than the product of pressure and current, but as a matter of fact the true actual power is always much less than this. This fact can also be very easily demonstrated by experiment, with apparatus arranged as shown in Fig. 4. Here is shown a wattmeter for indicating the true power in watts, and a voltmeter and ammeter. In such an arrangement where there are coils of wire, the product of the ammeter and voltmeter indication is always greater than the correct indication of the wattmeter. That is, the product of the ammeter and the voltmeter indications will need to be multiplied by a factor or a number *less than unity* in order to have the same numerical value as the indication of the wattmeter. This multiplying factor is called the "power factor"; designated by *P. F.* The power factor may be expressed as a fraction, or as a per cent by multiplying the fractional value by 100.

The relation of pressure, current, watts, and power factor may be expressed simply by symbols as follows:

$$P.F. = \frac{W}{E \times I}$$

in which W denotes the indication of the wattmeter, and E and I the indication of the voltmeter and ammeter, respectively. If the numerical value of W is the same as the product of the numerical value of E and I then of course the power factor is unity or 100 per cent. If a wattmeter should be connected with the straight wire shown in Fig. 1, the indication of the wattmeter would

be the same as the product of the voltmeter and ammeter indications, and the power factor is unity. In other words, whenever unneutralized inductance exists in an alternating-current circuit, then the power factor is always less than unity.

Considering now the condition represented by Fig. 4, where the applied alternating pressure is 110 volts, the indicated current 2 amperes, and the indicated watts 96.8, then the power factor is

$$P.F. = \frac{96.8}{110 \times 2} = \frac{96.8}{220} = 0.44 \text{ or } 44 \text{ per cent}$$

The important consideration of the effect of the power factor from an efficient operative standpoint is the numerical value of the current that corresponds with any given useful power output.

From the last given numerical values, the applied pressure was 110 volts, and the true power 96.8; therefore from a direct-current standpoint the current necessary for the power output would be only

$$\frac{96.8}{110} = 0.88 \text{ ampere}$$

This comparison leads to another consideration of power factor from the analytical standpoint that may be represented by the aid of a diagram; sometimes alluded to as a vector diagram, being made up of straight lines whose lengths denote the magnitudes of the quantities they represent, and whose directions indicate the relative directions in which the represented forces act.

For example, in Fig. 5 the line OA may represent a pressure of 110 volts while the line OB may represent a current of 0.88 ampere. The line OB is said to be in phase with OA and if the line OB represents an *alternating current* while the line OA represents an *alternating pressure*, the current is said to be *in phase* with the pressure. Now suppose the line OC represents by its length an alternating current of 2 amperes, while OA represents an alternating pressure of 110 volts. The position relation indicates that the current of 2 amperes is out of phase with the pressure, and is said to lag behind the pressure. Thus when the ammeter represented in Fig. 4 indicates 2 amperes, and the wattmeter indicates only 96.8 watts, the current is said to lag the pressure. The position of the line or vector OC representing 2 amperes, relative to the pressure vector OA has a very important bearing. Suppose a line as BD be drawn perpendicular to the pressure vector OA at point B, the end of the current vector; there can be but one position of the line vector OC so that the distance from O to the perpendicular is just 2 units in length, to represent 2 amperes. This fact establishes the *angular relation* of the current vector OC with the pressure vector OA. Also the length of vector OB is said to be the *projection* of the vector OC on the pressure vector OA. The angle between the current vector OC and the pressure vector OA is designated by Φ and from trigonometrical relation the vector or projection OB is equal to $OC\cos\Phi$ or $I\cos\Phi$. Therefore instead of expressing the true power as indicated by the wattmeter as $0.88 \times E$, it may be expressed by

$$W = E\,I\cos\Phi$$

in which $\cos\Phi$ denotes the "power factor."

By using the line OA as a diameter and constructing a semicircle as shown, extending OC to F, and drawing FA, the line OF represents the ohmic pressure drop in the coil, while FA represents the counter electromotive force of induction expressed by $2\pi fLI$.

OF is perpendicular to FA; or the angle OFA is a right angle, since it is inscribed or included in a semicircle. This being the case, the principle of the *Pythagorean Theorem* may be applied to the diagram; which is that the square of the hypotenuse of any right angled triangle is equal to the sum of the squares of the other two sides. Hence the following must be true:

$$E^2 = (RI)^2 + (2\pi fLI)^2, \text{ from which}$$

$$I^2 = \frac{E^2}{R^2 + (2\pi fL)^2} = I = \frac{E}{\sqrt{R^2 + (2\pi fL)^2}}$$

which corresponds to the initial equation of this article.

It is thus evident that wherever inductance is present, producing a power factor less than unity, a larger alternating-current is present in the circuit or apparatus than is really necessary to produce a given power output. Every alternating-current motor has inductance due to the windings of field and armature coils, and greatly augmented due to the presence of iron, which causes their power factor to be less than unity. This means that to furnish a required useful output in watts, larger currents are required than if the same output were furnished by direct-current motors, meaning either a greater loss of power in the transmission wires, or a greater interest charge on the cost of the increased amount of copper to prevent the increased loss. Because of the existence of inductance and its inherent power factor effects, alternating current motors for the same output weigh more than do direct-current motors.

The power factor of an alternating-current motor is not a constant; it varies considerably with variations in output. In the design of this type of motor the aim is to have the power factor as near unity as possible, at as near the normal rated output as possible. If, however, such motors are used to furnish a small fraction of their rated output, during considerable intervals, the low power factors attendant upon partial output, results in unsatisfactory financial efficiency.

To illustrate the effect of power factor on the cost of copper for a motor or a transmission line having a power factor of 44 per cent, and an actual alternating current of say 200 amperes, at 200 volts, is shown as follows: The true power is represented by

$$W = E\,I\cos\Phi = E\,I \times P.F.$$
$$= 200 \times 200 \times 0.44$$
$$= 40000 \times 0.44 = 17600.00 \text{ watts}$$

Were the power furnished by a direct current the current would be

$$\frac{17600}{200} = 88 \text{ amperes.}$$

The ohmic or heat loss in the copper conductor is expressed by RI^2. In the direct-current case, the loss is expressed by $R \times 88^2$ and in the alternating-current case by $R \times 200^2$. The ratio of the a. c. loss to the d. c. loss may therefore be expressed by

$$\frac{a.\,c.\,loss}{d.\,c.\,loss} = \frac{R \times 200^2}{R \times 88^2} = \frac{40000}{7744}$$

$$\text{or the a. c. loss} = \frac{40000}{7744} \times d.\,c.\,loss.$$

That is, the a. c. loss is over five times as great as the

d. c. loss would be, in furnishing the same amount of useful power. In other words in order that the alternating-current system shall compete with the direct-current system, the cross section of copper must be five times as great, or five times as much copper will be required in the alternating-current system or motor as in the direct-current system.

Of course if the power factor were 80 per cent, instead of 44 per cent, the results would be very different. With the power factor 80 per cent, the actual line current would be

$$I' = \frac{17600}{200 \times 0.8} = \frac{17600}{160} = 110 \text{ amperes}$$

in order that the actual useful power output remain at 17600 watts as when the power factor was 44 per cent.

The ratio of the two losses when the power factor is 80 per cent may be expressed by

$$\frac{a.\,c.\,loss}{d.\,c.\,loss} = \frac{R \times 110^2}{R \times 88^2} = \frac{12100}{7746} = 1.6;$$

or the a. c. loss = 1.6 times the d. c. loss.

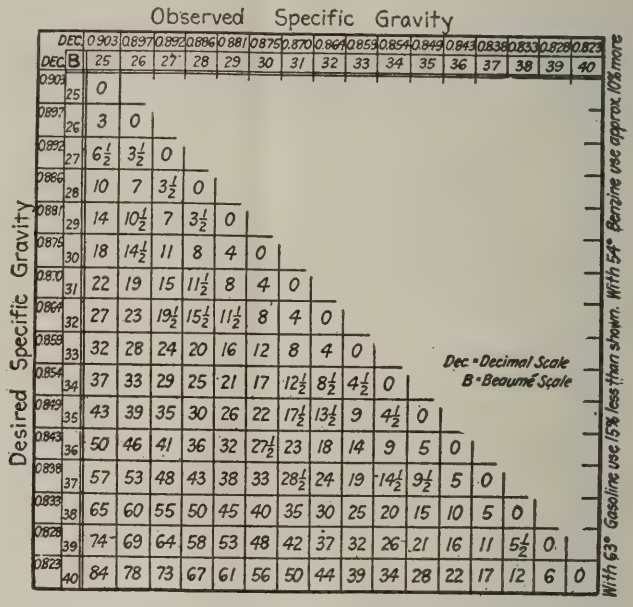
Suppose at the same output of 17600 watts, the power factor is 90 per cent; then the line current must be,

$$I'' = \frac{17600}{200 \times 0.9} = \frac{17600}{180} = 98 \text{ amperes.}$$

The fundamental principles explained in this article have very important application in the practical operation of motors. The conditions of operation at partial outputs, of various pressures, and the starting, stopping and reversal of motors will be the determining factors.

INSULATING VARNISH SOLVENT CHART

In order to prevent or assist in preventing the use of varnishes at wrong gravity, which affects the results obtained, the Dolph Manufacturing Corporation, New York, has just issued a copyrighted "Solvent Chart" showing the percentage of solvents which should be used with its insulating varnish to produce the right specific gravity. The specific gravity shown on the chart is that at which the varnish is shipped; it is given in both the decimal scale and the Baumé scale. The most suitable gravity for any particular use should be established by trial and endeavor made to keep this constant. The solvent chart indicates the amount of solvent to be added to reduce the varnish to the desired gravity. Benzine is preferable to gasoline as a solvent, but gasoline can be used. The solvent and varnish should be approxi-

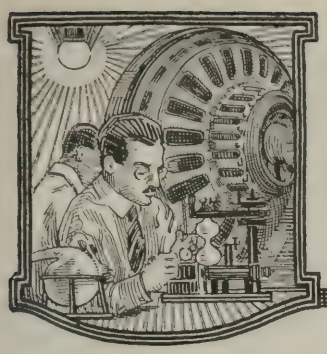

Observed Specific Gravity
Desired Specific Gravity
Dec. = Decimal Scale
B = Beaumé Scale
With 63° Gasoline use 15% less than shown. With 54° Benzine use approx. 10% more

Solvent Chart for Insulating Varnishes

mately at the same temperature and neither under 60 deg. Fahr. The solvent should be added slowly and stirred thoroughly.

As an example of the use of the chart, if it is desired to reduce from 30 B. to 32 B., the chart shows that 8 gal. of 58-deg. benzine would be necessary for every 100 gal. of varnish. To reduce from 0.864 (decimal scale) to 0.843, 18 gal. of 58-deg. benzine is required.

"Bolshevik a Plenty"

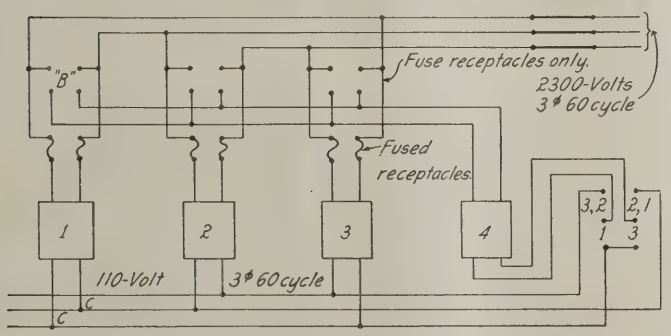


PRACTICAL STUNTS

An Emergency Transformer Wired for Service

The circuit illustration shows how a spare transformer can be connected into the service circuit so as to make use of it in the shortest time possible in case of an emergency. The main transformer bank consists of three 2,300-volt, 60-cycle, 3-phase transformers, with both primary and secondary sides of each connected in delta. A fourth transformer is installed for emergency use.

The customary installation consists of a fuse cutout in each transformer lead and a hook disconnecting switch in each phase. In order to connect the emergency transformer, so as to avoid as little wiring and other work as possible in case of emergency, additional fuse holder receptacles are installed—one in each lead



Circuit Arrangement for Emergency Transformer

connected in parallel as shown at "B" in the illustration with the opposite side connected to the emergency transformer.

The secondary side of the emergency transformer is connected to the center poles of two single pole, double throw switches. The other contacts of these switches are connected to each phase of the 110-volt circuit, as shown.

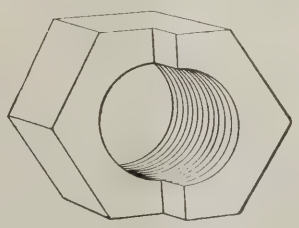
If for some reason or other transformer No. 1 gives out, all that is necessary to do in order to put the emergency transformer into service is to pull the fuses on transformer No. 1, as shown at "A," and insert them in receptacles at "B." Transformer No. 1 is then disconnected on the secondary side at "C" and the single pole double throw switches are closed into contacts 1, 1. If any other transformer fails, a similar procedure is necessary, except that the single pole double throw switches are thrown into other contacts according to the numbers indicated in the sketch. The total time required in making the change is not over five minutes and everything is left in a permanent shape as far as the maintainer is concerned. The faulty transformer may then be removed for repairs when convenient.

On an installation where this scheme of circuits is used, the transformers are mounted on a concrete table, which is provided with an oil trough of sufficient capacity to hold the contents of one transformer. The trough is provided also with a drain to draw off the oil. The wire work is all overhead, using standard construction.

Cleaning Tension Rod Threads

By George Esterhammer, Electrical Dept. Pullman Car Lines Company, Pittsburgh, Pa.

It frequently happens that the threads on the tension rods of truck-hung generators become clogged with dirt which is hard to remove, and considerable time is spent in trying to clean the threads with knife or screw driver when it becomes necessary to replace a worn out wrench with a new one. Another method of removing the dirt is run a die over the threads, but dies are expensive and it is not possible for each generator man to carry a die with him; nor is the screw driver or knife method satisfactory. I feel that the contrivance which I describe herewith will be a great help to generator men in general.

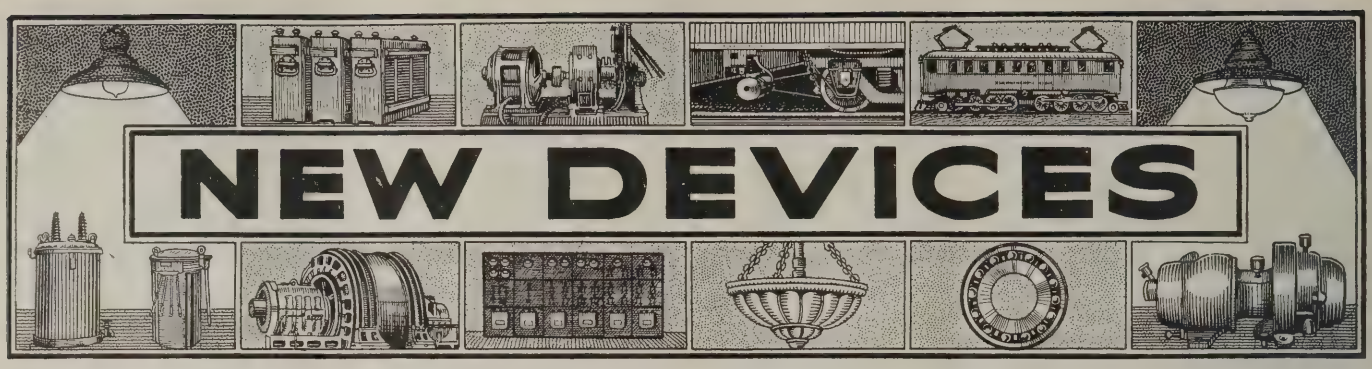


How a Common Nut Can Be Altered for Cleaning Threads

The device is simple in the extreme and consists merely of a 7/8 in. square or hexagon nut with a portion cut away as shown in the sketch. Due to the fact that the nut is cut in this manner the dirt falls to the ground instead of entering the nut and causing it to bind. After running the nut over the old rod, the application of a new wrench is a simple matter. I have found that it requires less than half the time and effort to clean the threads by this method than it does with a die.

A Lubricant for Axle Generators

The Chicago Great Western have had fine results by using white lead and oil as a lubricant to prevent the rusting of armature cores, shafts, armature pulleys, ball bearings and dynamo suspension pins.



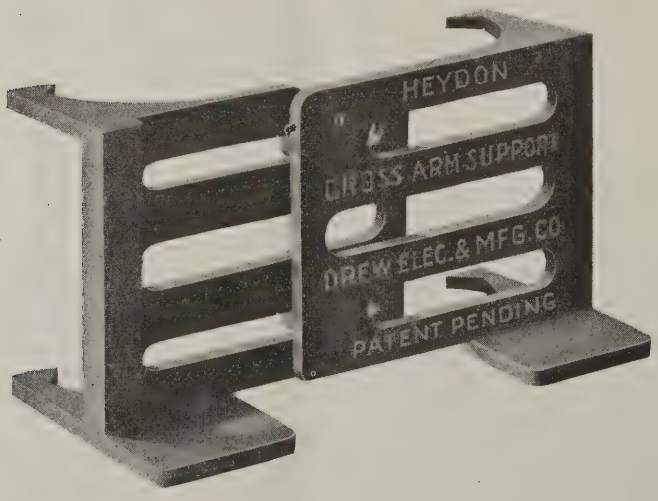
Double-Throw Pole-Top Disconnecting Switches

The Electrical Engineers Equipment Company, 710 West Madison street, Chicago, Ill., has developed a type of double-throw switch which accomplishes the switching from one line to another in one complete operation. A provision is also made whereby the feeder can be disconnected from both lines, the switch blade remaining in the neutral or open position. The switch is arranged to lock in all three positions.

The new unit is constructed by using a standard type No. 400, single-break switch, manufactured by the same company and adding a cross pipe which carries three additional insulators each equipped with jaw contacts. An upward thrust or a downward pull on the operating pole which is connected to a toggle mechanism throws the switch to any position. Each switch is equipped with arcing horns and sleet hoods.

The Heydon Cross Arm Support

A new type of cross arm support known as the "Heydon" has recently been put on the market by the Drew Electric & Mfg. Co., Indianapolis, Ind. The Heydon Cross Arm Support eliminates the necessity of cutting a gain in the pole, gives greater contact or bearing surface

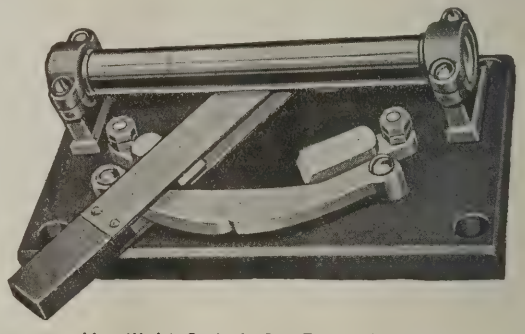


The New Cross Arm Support

and requires only one bolt. It does not disfigure or weaken the pole but on the contrary reinforces it. It is claimed by the manufacturers that 60 per cent of the time required in mounted cross arms by the old methods can be saved by using the new support. The support is adjustable to fit any size pole, having four dogs which hold it firmly to the pole. The sustaining platform prevents side sway or strain, holding the cross arm squarely in position.

Locomotive Headlight Switches

The Keystone locomotive headlight switches now being made by the Electric Service Supplies Company, Philadelphia, New York and Chicago, are especially designed for control of electric headlights on locomotives. They are made in different types to meet the varied conditions which exist in this service. The switch, as illustrated, however, is typical of the entire line and probably is the most commonly used, since it provides "off" and "on" connections and in addition has a ferrule type resistance mounted upon its base which is used for dimming the headlight lamp. The switch illustrated, there-



Headlight Switch for Road Engines

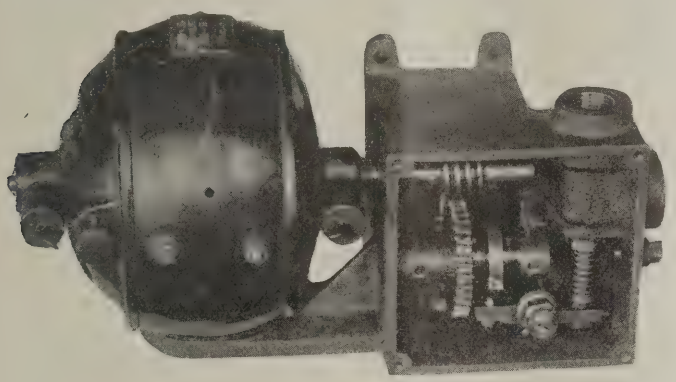
fore, has three positions from left to right, "on," "off" and "dim."

The switch blades operate in a plane parallel to the base and so close to it that the blade handle is not so liable to injury, in any position, as is the case with the ordinary knife switch. The base is of heavy composition insulation. The switch blades are of the duplex type, spaced apart at their upper end by a contact bridge and bolted to it. At the lower end of the blade this spacing is made by the handle. A curved guide which acts as a support to the blades prevents bending or distortion. The blades wipe over the upper and lower surfaces of the side contact blocks. The switch blade is held at its "off" point by a spring plunger which engages momentarily into a notch in the guide. Resistance units used are of the ferrule type. The switches are of rugged design to meet the severe requirements of locomotive service. All parts are made on an interchangeable basis so that repair parts will fit when ob-

tained from the factory. This applies not only to the parts for any particular form of switch, but all similar parts are interchangeable on any type of switch.

Sand on Axle-Generator Belts

The Safety Car Heating and Lighting Company, New York, has developed a device to prevent slipping of axle generator belts for trains operating in severe winter weather. This device operates by automatically depositing sand on the belt. A small motor is mounted on the frame of a small metal case located at some convenient place on the car. Geared to the armature shaft of the motor is a valve operating mechanism, whereby a valve is opened at predetermined intervals, releasing air under



Sanding Motor and Mechanism

pressure from the air brake system. The velocity of this air passing through an injector carries a spray of sand onto the generator belt, counteracting any effects of ice on the pulleys. The sand is stored in the locker or some other suitable place and feeds through a pipe to the injector. The motor operating this device is connected directly to the lighting generator so that the sander is only in operation while the train is in motion. When the service of the sander is not required it is disconnected from the axle generator by a switch.

Self-Centering Chucks Facilitate the Boring of Motor Bearings

A form of automatic chuck has been developed in the shops of the Third Avenue Railway, New York, for boring railway motor-armatures and axle bearings. The chuck is the invention of Harry J. Krombach, assistant general foreman of that company. It is in use in the properties of other large railways. The development of this device has resulted from an effort to reduce the cost of finished bearings.

Various forms of holding devices are used for this work. Some are specially designed and constructed for this purpose while others use the U-shaped jaws of the regular made chuck. Where the regular chuck is used considerable time is consumed in setting up for the boring operation, and as the jaws bear at four points on the circumference of the bearing, there is a tendency to force the bearing out of line if too large a cut is attempted and bearings can be distorted by excess pressure of the jaws.

The chuck developed by Mr. Krombach consists of two cast-steel parts, the body or jaws of the chuck and the feed nut which actuates the jaws. Its weight is 45 pounds, and it can be readily adopted to operate satisfactorily on any type of lathe.

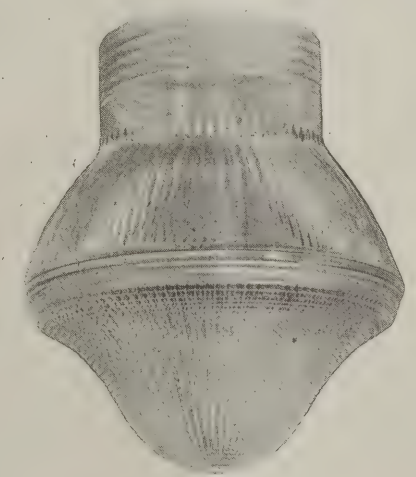
In order to eliminate the possibility of an inaccurate fit, the chuck is provided with the spindle end of the body untapped. Experience has shown that sometimes in tapping the casting for the lathe spindle connection there is the liability of this being made "out of true." With the final cut made on the lathe with which the chuck is intended to operate, this risk is avoided.

The inside body or jaw of the chuck provides for a compression of about 5 per cent of the diameter. With a 5-in. maximum-capacity chuck, for instance, it is possible to hold rigidly any bearings having an outside diameter of not less than 4¾ in. and not exceeding 5 in. Where smaller bearings are to be held it is necessary to introduce a reducing sleeve having slots which form jaws parallel with those in the body of the chuck. By the use of such sleeves, smaller diameter bearings can be held rigidly. The chuck is manufactured and supplied by J. E. Coonan, New York.

Vapor Proof Reflector Globes

A considerable amount of the lighting in railroad buildings calls for the use of moisture and vapor-proof fittings. In the past it has been standard practice to equip vapor-proof lighting fittings with clear glass globes, and in order properly to direct the light and obtain an efficient lighting unit it has been necessary to place a reflector over the glass globe.

The Holophane Company, New York, has designed a combined vapor-proof globe and reflector by using the well-known prismatic construction. Reflecting prisms are on the upper portion of the globe to redirect the light in downward directions and the refracting and diffusing prisms are on the lower surface to distribute the light in



Globe Ready for Mounting In Standard Vapor Proof Fitting

different directions in the desired proportions, so that the resulting illumination on the work will be uniform. Tests show that the illumination is increased by 75 per cent over that given by an ordinary clear vapor-proof globe.

These vapor-proof reflector globes are made for the 40 and 60-watt type B lamps and for the 75, 100 and 150-watt type C lamps for use in connection with the standard vapor-proof fittings now on the market, including the standard navy thread.

General News Section

Shopmen on the Baltimore & Ohio at Cumberland, Md., went on strike on Tuesday, September 2. There are seven classes of mechanics represented among the strikers and they ask for an increase from 68 to 85 cents an hour. All mechanic helpers ask a raise from 45 to 60 cents an hour.

The Central Steel Company, Massillon, Ohio, has opened new offices in Detroit, Mich., in the Book building, 35-57 Washington boulevard, Rooms 848-9-50. Arthur Schaeffer, former assistant director of sales at the home office, Massillon, has been appointed district manager of sales with Frank Gibbons as his assistant.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has recently opened an office at Detroit, Mich., located at 905 Kresge building, to expedite the handling of orders and to give the company's customers in and about Detroit better engineering service. H. S. Kinsley will be in charge of the Detroit office and will be assisted by C. W. Greenman and M. Dugliss.

The Bureau of Standards, Washington, D. C., is getting out in tentative form the changes proposed for Part I of the National Electrical Safety Code which covers rules for the installation and maintenance of electrical supply stations and equipment. These changes are not radical in character but are intended to cover points which were omitted in the previous editions of the Code or which seemed to need clarification.

Four cars of an eastbound freight train buckled on a track adjoining that on which the eastbound Twentieth Century Limited of the New York Central was running, east of Painesville, Ohio, about 29 miles east of Cleveland, Ohio, on August 31. The Century ran into the wreckage and its engineer was killed. The locomotive and passenger cars of the Century remained on the track. A few passengers were injured by broken glass.

The Trumbull Electric Manufacturing Company announces that the General Electric Company has acquired a financial interest in their company. No changes whatever will be made in the present management, or the personnel of the company. The business of the Trumbull Electric Manufacturing Company will be carried on in the future exactly as it has been in the past in every particular. It will be the policy of the company to sell its material through the same distributors as in the past and on the same basis as to terms, price and service.

The Schroeder Headlight and Generator Co., of Evansville, Indiana, manufacturers of the "Sunbeam" electric headlight system, announce the opening of two new offices. One of these offices, in charge of Harlow A. Varney, district sales manager for the company, is located at 1051 McCormick Building, Chicago. The second office, at 507 New Call Building, San Francisco, will be the headquarters of S. Herbert Lanyon, district sales manager for the Pacific coast territory. Both Mr. Varney and Mr. Lanyon have had a number of years of experience in the railway supply business and enjoy a wide acquaintance among railroad men.

The Drew Electrical & Manufacturing Company, Indianapolis, Ind., manufacturers of overhead electric railway materials, started work on July 11 on its new factory in Cleveland, Ohio, which it is expected will be finished about September 1. The first unit, now being built, will be a brick and steel structure 80 ft. by 205 ft., with a two-story section devoted to the general offices and engineering department. This building will have about 20,000 ft. of floor space and will include machine and assembly shop and brass foundry. A contract for the second unit of the factory will be let soon. This will be 40 ft. by 60 ft. and will house the hot galvanizing plant.

The National Tube Company, Pittsburgh, Pa., announces that they have made arrangements with the National Metal Molding Company, of Pittsburgh, and the American Circular Loom Company, of New York, to act as their distributors of Spellerized mild steel tubing, made especially for the manufacture of rigid steel conduit. The National Metal Molding Company will market this conduit under the trade name of "Sherarduct" and "Economy." The "Sherarduct" is the sherardized rigid steel conduit and the "Economy" is the black enameled rigid steel conduit. The American Circular Loom Company is marketing these same products under the trade names of "Xduct" and "Electroduct."

The Electrolytic Oxy-Hydrogen Laboratories, Inc., announce the formation of a sales and manufacturing company under the name of the Electrolabs Company. The Electrolytic Oxy-Hydrogen Laboratories, Inc., will continue in charge of the laboratories and maintain a technical supervision over the work of the new company. The general offices and works of both companies have been, moved from Dayton, Ohio, into larger quarters at 2635 Penn Avenue, Pittsburgh, Pa. The general sales offices are being continued at 15 William street, New York City, and branch sales offices have been opened in the Morris Building, Philadelphia, and in the Merchants Exchange Building, San Francisco. I. H. Levin continues in charge of technical and research work, and D. J. Tonkonogy in general charge of sales.

Steam vs. Electrical Working of Locomotives

London.

An abstract by the Technical Supplement of the Review of the Foreign Press from an article in the Zeitschrift des Oesterreichischen Ingenieure- und Architekten-Vereines, states that the railways of German-Austria only use about one-tenth of the entire coal consumption of the country. Details of the coal consumption are given, pointing out that with the modern superheaters

the locomotive has become much more efficient than formerly. Steam locomotives are stated to work more efficiently than electric locomotives, especially where goods trains are concerned; and even in Switzerland the cost per ton-kilometer on the electric railways is often higher than on the railways worked by steam. The whole argument is to the effect that only under certain conditions will electrical working prove cheaper than steam working.

New Wireless 12,500 Miles

The new wireless station to be erected at Croix d'Hins, near Bordeaux, will have a sending radius of 12,500 miles, according to the Excelsior. It will be one of the most powerful wireless stations in the world, the paper adds, with five times the strength of the Eiffel Tower, three times that of Lyons and twice that of Naum. The station will have a capacity of 72,000 words daily and will reach all the French colonies throughout the world.

Eleventh Annual Convention of the Association of Railway Electrical Engineers

The annual convention of the Association of Railway Electrical Engineers will be held at Chicago during the week beginning Monday, October 27. It was impossible to make arrangements to hold the meetings this year at the Hotel La Salle, and the Morrison Hotel was secured for the purpose.

It is expected that the exhibits will be ready by six o'clock on Monday, the regular convention sessions beginning the next morning, and extending until Friday.

Illuminating Engineering Society Plans Annual Convention

The Illuminating Engineering Society, which for the past two years has been prevented from holding its annual three-day convention on account of the demands of the war, is planning to return to the old custom of holding an annual convention in the Fall. Arrangements have been made to hold the convention at the Hotel Sherman in Chicago beginning Monday, October 20, and closing on the 23d.

The Papers Committee is paying particular attention not only to the providing of a generous supply of papers, but also to securing those that will treat of the Science and Art of Illumination in so complete a fashion that something of interest will be found for every man in the lighting industry, whatever his specialty may be.

The Chicago Electric Show, which will be in progress at the same time as the convention, will prove an added attraction since the program will provide for a visit to and an inspection of the exhibits, particularly those covering the lighting field.

St. Paul Adds 110 Miles to Electrified Line

President Calkins of the Chicago, Milwaukee & St. Paul says that in a few days electric current will be turned on over another 110 miles of main line from Othello to Cle Elum, Washington. By January 1 the road will be completely electrified from Harlowton, Mont., to Seattle, 885 miles, or within 200 miles of half the entire length of the St. Paul-Seattle line.

The last stretch from Cle Elum to Seattle, 130 miles, will cost about $9,000,000, or 25 per cent to 40 per cent more, relatively, than preceding units, on account of higher prices of labor and material.

Electrification has doubled train tonnage, says Mr. Calkins.

U. S. Light and Heat Corporation Hold Election

At the annual meeting of the stockholders of the U. S. Light and Heat Corporation, held at the offices of the company at Niagara Falls, Wednesday, August 13, the following directors were elected: R. C. Caples, E. H. Gold, J. E. Kepperley, C. L. Lane, C. O. Miniger, J. O. Moore, B. J. O'Reilly, J. A. Roberts, G. G. Shepard, J. Allan Smith, J. N. Willys.

Immediately after the meeting the directors elected the following officers for the ensuing year: John N. Willys, chairman of the board of directors; E. H. Gold, vice-chairman of the board of directors; J. Allan Smith, president; C. L. Lane, vice-president and general manager; R. C. Caples, vice-president; B. J. O'Reilly, treasurer; R. H. Van Nest, secretary; T. G. Swannie, assistant secretary and assistant treasurer.

Electric Regeneration on Swiss Single Phase Railways

The first experiment, on the recovery of the electric energy, which the braking or down-grade movement renders available, were made on the Lötschberg line of the Swiss Federal Railways on June 27. The system tried was that of the Maschinen fabrik Oerlikon, and the success is described as complete. The tests were conducted with the locomotive which the Oerlikon Company, in conjunction with the Lokomotivfabrik Winterthur had built for the Gotthard Railway, and which has since May been in regular service in the Bern-Thun Railway. In the tests the engine was run at different speeds, up to 70 km. per hour, down hill, first empty, and then with a load of 310 tons, without making use of the mechanical brakes or of any brake resistances. It is said that the remarkably simple devices operated to complete satisfaction from the start, and the detailed account of the tests will hence be a matter of considerable interest.

Water Power in Spain and Electrification

Spain's water power in the various parts of the country available for immediate use for electricity has been computed as follows by Españia Economica y Financiera:

	Kw.
Atlantic slope of Leon and Galicia	70,000
Asturias	40,000
Santander	30,000
Ebro above Saragossa	65,000
Rivers of the Pyrenean slopes	490,000
Ebro from Saragossa to the sea	130,000
Douro within Spain	90,000
Douro on the Portuguese frontier (falls)	150,000
Tributaries of the Douro	50,000
Tagus	110,000
Tributaries of the Tagus	50,000
Guadiana	35,000
Guadalquivir and other Andalusian rivers	40,000
Jucar and Cabril	90,000
Other Mediterrancan rivers	60,000
Rivers of minor importance	500,000
	2,000,000

Certain American financiers, in co-operation with important units of the Constructora Naval, are said to be proposing to found a company which will utilize all the electric power in the country for the purpose of electrifying the whole railway system of Spain. The capital of the proposed company will be Pes. 200,000,000.

PERSONALS

D. C. WILSON, electrical engineer, of the Central of Georgia Railway, with headquarters at Savannah, Ga., has resigned to enter private business as a dealer in the Delco light products at Chattanooga, Tenn.

R. E. CLINE, formerly an electrician on another road, has been appointed division electrician on the Chicago, Rock Island & Pacific R. R. with headquarters at Liberal, Kan. Mr. Cline took up the duties of his new position August 16, 1919.

A. M. CRAIN, consulting engineer with offices in Detroit, Mich., specializing in the construction of railway terminals, grain elevators, power plants and industrial buildings, has been appointed vice-president of the WITHERSPOON-ENGLAR COMPANY, Chicago.

E. T. SAWYER has recently accepted a position as a representative of the railway sales department of the U. S. Light & Heat Corporation, Niagara Falls, N. Y. Mr. Sawyer will specialize on car lighting equipment and electric arc welders and will make his headquarters at 30 East 42d Street, New York.

GEORGE HULL PORTER, who has been in charge of sales in the middle west, for the Western Electric Company, Inc., New York, has been appointed railway sales manager and will direct the company's railway business for the entire country. Mr. Porter will continue to have his headquarters at Chicago. He was born on July 30, 1883, at Danbury, Conn., and received his education at the Mount Pleasant Military Academy, at Ossining, N. Y. Since 1902 he has spent practically all of his time in the electrical industries, becoming a member of the Western Electric Company's organization in April, 1908, as a steam railway salesman connected with the Chicago office. Some time after that he became western manager of the railway sales department. Mr. Porter, in addition to becoming president of various railroad and electrical associations and chairman of civic societies and committees, has also been for some time captain in the First Regiment of the Illinois Reserve Militia. In 1918, he entered the government service, serving on the staff of the quartermaster general as a private and received a commission of captain sometime after. He rejoined the ranks of the Western Electric Company in December, 1918.

G. H. Porter

AUGUST G. MUELLER, formerly electrician for the Chicago, Rock Island & Pacific R. R. at Rock Island, Ill., who has just returned after two years' overseas service with the 311th Supply Train, has been appointed division electrician with the Rock Island Lines with headquarters at Valley Jct., Iowa, effective August 1, 1919. Mr. Mueller succeeds FRANK C. CLIFTON, who resigned to go into business for himself.

John Kelly, who for a number of years was New York district manager of the Edison Storage Battery Company, has been appointed general sales manager of the company, with headquarters at Orange, N. J. This promotion for Mr. Kelly follows closely upon his promotion, on July 1 of this year, to the position of assistant general sales manager. Mr. Kelly brings to his new position the experience of a long and varied career in the storage battery, electric vehicle and accessory business. For nine and one-half years he was district manager of the New York office of the Edison Storage Battery Company. Before that he had been a salesman for the Westinghouse Storage Battery Company for two years, for the Swinehart Tire & Rubber Company for three years, for the Firestone Tire & Rubber Company for two years, and for the New York Edison Company for nearly four years.

John Kelly

TRADE PUBLICATIONS

The Onondaga Steel Company, Syracuse, N. Y., has prepared a graphic color chart containing directions for cutting on high speed steel for tool lengths, for forging and hardening forged tools, milling cutters and finished tools, and for tempering and annealing, with the temperatures for the different operations shown in color.

The Bastian-Blessing Company, Chicago, Ill., has recently issued its new catalog describing the principles underlying the design of the welding and cutting apparatus manufactured by the company. The product of the company, the "Rego" torch, which is an oxy-acetylene device, is claimed by its manufacturers to have eliminated all possibility of flashback.

The Electric Storage Battery Co., Philadelphia, Pa., has recently issued a 44 page pamphlet entitled "15 Points of 'Ironclad-Exide' Storage Battery." The little booklet contains many illustrations showing the uses made of the Ironclad-Exide Battery in the operation of trucks, tractors and various other electrical vehicles, as well as giving an extensive description of the different parts of the cell.

The Stromberg Electric Company, Chicago, Ill., have issued a folder describing their automatic time systems in which a master clock controls various pieces of secondary equipment, such as secondary clock for indicating time in various places, in-and-out time-recorder for recording time of arrival and departure of each employee, program instrument for automatically blowing whistles, ringing bells, etc., office time stamp for stamping time and date of receipt of letters and other similar devices.

Railway Electrical Engineer

Volume 10 October, 1919 Number 10

THE ELEVENTH ANNUAL CONVENTION

The volume of the committee reports which are presented in this issue of the *Railway Electrical Engineer* exemplify the fact that the eleventh annual convention of the Association of Railway Electrical Engineers was the most successful convention that the Association has ever held. The fact that arrangements could not be made to hold the convention at the Hotel La Salle, which has been the custom in previous years, did not detract in the least from the value and importance of the event since the Hotel Morrison, which was the convention headquarters this year, was quite satisfactory and its appointments are such that Association members were fully as well accommodated as in the past.

In keeping with the usual customs the Railway Electrical Supply Manufacturers' Association exhibited their products at the hotel and a very attractive display of apparatus was presented.

Among the committee reports of the Association of Railway Electrical Engineers there are three which cover very completely the various phases of electric headlight operation. This subject is particularly interesting this year as the time is rapidly approaching when all locomotives must be equipped with high power headlights to conform with the Interstate Commerce Commission's ruling to that effect. The question of electric headlight installation was given considerable attention at the annual convention last Fall and again in June when the Association held its semi-annual meeting at Atlantic City. On both occasions there were a number of diversified opinions as to what should be considered standard practice. The chief difficulty appeared to be that no railroad had used electric headlights long enough to have developed methods of installation and maintenance that other roads were willing to accept as perfect. It is very probable that for some years to come headlight practice will continue to undergo considerable change in the matter of installation. So far as manufacturers' equipment is concerned the apparatus has been developed to a very high degree of excellence and the indications are that the different roads will eventually adopt such practices in the way of installation as are best suited to their own particular requirements.

The trend of the times is clearly reflected in the valuable report presented on the subject of Electrification. With the constantly rising cost of coal there is bound to be an ever increasing interest in the matter of heavy electric traction. The advantages of electrification are so generally recognized that it may almost be said that they are universally accepted as representing the ideal condition for railroad operation. The chief drawback to the rapid increase in electrified mileage is the tremendous initial investment required and it will be many years before anything approaching a general electrification of even the larger roads could be justified. This does not mean, however, that progress in this work will remain stagnant for at present there are localities where electrification to a limited extent could not be considered other than a paying investment. Succeeding years will increase the number of such localities and slowly, but with certainty, electrical operation will come into its own. There is, however, another phase of the problem which should not be overlooked and that is the improvements that are reasonable to expect both in the design of electric locomotives and in the distribution of power.

THE CONVENTION ISSUE

As has been our custom in previous years, the present issue of the *Railway Electrical Engineer* contains the complete committee reports that were presented before the annual convention of the Association of Railway Electrical Engineers at Hotel Morrison, Chicago, beginning October 28. The number and length of these reports, as well as their importance to electrical men on steam railroads, are such as to make it advisable to exclude from this issue many of the regular articles which would ordinarily appear. It is believed, however, that the reports of the several committees, coming as they do from different sections of the country, will make a valuable substitute since these reports from their very nature reflect the latest practices of the different roads throughout the country.

That the convention issue reaches your hands a little later than usual is due to a combination of circumstances. The strike which occurred among certain branches of the printing industry in New York on October 1st made it necessary for the October number of the *Railway Electrical Engineer* to be published in Cleveland, O., instead of at the regular office of pub-

lication. The question of printing, however, was handled with dispatch and we hope that our subscribers will bear with us through the delay which has been caused by the unusual circumstances. It is our desire to have your copy of the *Railway Electrical Engineer* which contains the reports of the committees of the Association of Railway Electrical Engineers in your hands as soon as possible. Therefore we are including in this issue the reports with an outline of the discussions which followed each report. This association deals most intimately with railroad electrical problems and no one connected with electrical work in the railroad field can read the reports without finding much to interest him.

THE PRESENT STRIFE

A more complete upheaval of industrial conditions than that through which we are passing today would be difficult to imagine. There is scarcely an industry throughout the entire United States, one or more branches of which have not been infected with the strike virus. The strike epidemic has spread from coast to coast, paralyzing industries and postponing indefinitely any possibility for a reduction in the high cost of living in the near future. The unprecedented police strike in Boston marks one of the most peculiar vagaries of the nation-wide epidemic, while the coal and steel strikes are of great magnitude.

One of the principal causes of all of this present strife is unquestionably the cost of living, which, while high at the close of the war, has been steadily increasing ever since, and under the influence of strikes, race riots and civil unrest shows no signs of abating. The great majority of the people appear to be indifferent to those things which would make for a material reduction in the cost of living, such as increased production or a tendency toward thrift. This spirit, together with demands for more money and shorter hours, has brought about such a state of affairs that the most optimistic business man looks upon the future with many misgivings. It is impossible to formulate plans for the promotion of business because no one can tell how soon such plans may be made worthless by some demand which cannot be foreseen. Of necessity, then, business is carried on from day to day without any attempt toward a stabilized plan of progress.

There is another factor which is particularly noticeable in the big strikes and that is the large number of unnaturalized foreigners among the strikers. There is no doubt that the general ignorance of this element, together with its inability to read or understand the English language make it easy prey for the radical strike promoter. Whether the reason for striking may be justifiable or not, it is a simple matter to influence the minds of these ignorant foreigners to almost any extent, and when this has been accomplished arson, riots, fighting and blood-shed follow as a natural sequence. With such conditions prevailing, the question of Americanization looms up as being of more than ordinary importance, and if these things are to be prevented in future years, the most diligent efforts will have to be made to educate this foreign element which forms so large a factor in our social and industrial life.

OPTIONAL DAYLIGHT SAVING

On the twenty-sixth of October, the clocks of the nation were turned back one hour to correspond with sun time and the war-time national daylight saving measure ceased to be the law of the land. When the change of time occurred, it did not excite more than passing comment, but next spring the advocates of the daylight saving plan will certainly miss the advantages they have enjoyed during the past two years unless means are taken to continue the plan by some arrangement other than national legislation. That the measure has many friends was strongly evidenced by the fact that the bill for its repeal was twice vetoed by President Wilson; the fact that the plan was eventually repealed does not signify that the majority of the people are in favor of abolishing the measure. What it does show is that those antagonistic to the daylight saving law were able to bring a more concerted influence to bear upon the Congress and secure the result they desired.

The line of demarcation between the advocates and opponents of daylight saving is clearly drawn. On the one side is found the population of cities and towns; on the other, the farmers and the lighting corporations. With war as an incentive it was possible to preserve harmony among these factions but with this common bond removed, the points of difference were not slow in springing up with the result that the daylight saving plan is irrevocably lost unless some steps are taken to perpetuate it through conferences between municipal officers and representatives of various industrial associations, including of course, employes' associations. Since the matter is no longer a national issue, it is more than likely that there will be numerous sections of the country in which no attempt will be made to return to the daylight saving plan. Endless confusion would result in changing the clocks in some places and not in others, so that any such means could not be tolerated. From the standpoint of the general public, however, there is no reason why the benefits of the daylight saving plan should not be retained in any locality that desires them. It simply means that business must begin one hour earlier. In reality, that is all that has been done during the past two summers.

There is, however, a more serious aspect to the matter from the railroad point of view, which cannot well be overlooked. The large cities in which are found the greatest number of advocates of the plan, are daily supplied with workers from the surrounding suburbs. To meet the demand for transportation for this daily influx of thousands an hour earlier than usual, would necessitate a great change in suburban train schedules.

Association of Railway Electrical Engineers Eleventh Annual Convention

October 28-31, Chicago

THE opening session of the eleventh annual convention of the Association of Railway Electrical Engineers was called to order by the president, J. E. Gardner, of the Burlington, at 10 a. m., October 28, in the Hotel Morrison, Chicago. The meeting began with 42 members present.

President Gardner in a brief opening address emphasized particularly the necessity for active discussion by all members during the meetings to follow. He stated that while the business of the members was primarily electrical, they should not hesitate to express their opinions even though they did not consider themselves speechmakers to any appreciable extent.

President Gardner also expressed the appreciation of the association for the splendid array of exhibits which the Railway Electric Supply Manufacturers' Association had provided. He urged upon the members the necessity for beginning the meetings promptly so that ample time could be had to carefully discuss the important features of the several committee reports.

At the close of the president's address those members who had joined the association recently were asked to rise and give their names and the roads with which they were connected. Twelve new members complied with this request.

The secretary-treasurer, Joseph A. Andreucetti, read an announcement addressed to the members of the association, from the *Railway Electrical Engineer* in which was stated the difficulties involved in getting the committee reports printed. A vote of thanks was Report of Committee on Electric Headlights followed. operation in making the publication of the reports possible. Mr. Andreucetti then read the report showing the excellent financial status of the association which was immediately followed by the report of the Auditing Committee verifying it.

Attention was called to the fact that the program had been so arranged that only one lengthy report had been included in each session. It was clearly brought out that the interest of the members should first be centered in the convention meetings and second in the exhibits. Mr. Andreucetti stated that in all his years of experience in connection with the convention that never had matters pertaining to the exhibits proceeded with such harmony and smoothness as this year.

There being no unfinished business the meeting adjourned until 2 p. m.

The afternoon session on Tuesday began with a very interesting talk by Phil A. Grau, vice chairman, Mississippi Valley, Chicago Association of Commerce, on the subject of industrial unrest. In a strong address Mr. Grau pointed out that the great industrial unrest which exists today not only in the United States but throughout the entire world was the direct result of the removal of the tremendous nervous strain under which all people labored during the war. He expressed his complete faith in the future welfare of the country and the eventual satisfactory outcome of business conditions. For the present he urged that men should take a more active personal interest in government affairs and that all should cultivate courage, conservation and thrift. The Report of the Committee on Electric Headlights folowed.

Standardization of Locomotive Headlight Equipment

Recommendations Include Generator Base Plate, Steam Pressure Range, Ball Bearings, Brush Sizes, Etc.

Your committee has carefully analyzed and reviewed its report as rendered at the semi-annual meeting in Atlantic City, June 23, 1919, and has also given careful consideration in two of its meetings, held since the semi-annual meeting, of the criticisms, suggestions and discussions which were recorded after the presentation of the original report, and after careful consideration of this subject again respectively submits the original report together with the following addenda which represents, as indicated above, the result of work accomplished since the semi-annual meeting. It is the thought of the committee that the original report together with this addenda be co-ordinated and accepted as the report of the committee for this year and that the report be so recorded in this year's proceeding. (The original report is not included here but it can be found on page 211 of the *Railway Electrical Engineer* for July, 1919, as well as in the 1918 Proceedings of the Association of Railway Electrical Engineers.

It is further recommended that this committee be continued and the subject pursued further, to the end that definite recommendations may be made possible for standard practice on the railroads.

Consideration of Standardization at Joint Meeting of the Committee and the Manufacturers

As recommended by the committee and Mechanical Section 3 of the American Railroad Association, relative to possible standardization of certain features of electric headlight equipment, a meeting was held August 25 at the Hotel La Salle, Chicago, with representatives of the headlight manufacturers upon request of the secretary, at which meeting the standardization matter was thoroughly discussed.

The manufacturers represented at this meeting were as follows:

General Electric Company	3 representatives
Pyle-National Company	2 representatives
Schroeder Headlight & Generator Company	2 representatives
Electric Service Supplies Company	2 representatives
Buda-Ross Company	1 representative

United States Headlight Company..... 2 representatives
Loco Light Company..... 1 representative

The subjects discussed with the representatives regarding standardization were as follows:

(1) Bolt spacing for turbo-generator mounting.
(2) Steam pressure range of turbo-generator.
(3) Turbo-generator ball bearings.
(4) Dynamo brushes.
(5) Size of steam pipe and drain pipe connections.
(6) Kind of lubrication, oil or grease.
(7) Exhaust head or muffler for turbine exhaust.

These subjects were taken up in the above order, the manufacturers' representatives in turn giving their views as to possible standardization of the various features involved and furnishing data in connection with details of construction of their several equipments.

The sentiments of the manufacturers were favorable to standardization of such of the features as might be possible without any radical changes in the design of their equipments and they showed a willingness to co-operate in the matter of using parts, such as ball bearings, which are of standard manufacture and available in the open market. The matter of standardizing the bolt spacing of the turbo-generators was apparently out of the question, as such a requirement would necessarily involve extensive changes in the construction of their machines and in view of the large number of equipments already in existence, the matter was temporarily dropped as being impracticable at this time.

To overcome this difficulty, however, it was the general opinion that the only solution was to adopt a plate, drilled if possible with holes so located that any of the standard makes of machine might be placed thereon and readily bolted down without the necessity for changing the entire generator mounting brackets.

Generator Base Plate.—Dimensions and bolt hole spacing of various machines were furnished by the representatives from which data a drawing was to be made up which would show, if possible, a mounting plate worked out along this line. This was worked out by one of the members and was taken up for consideration at the second meeting of the committee.

Steam Pressure Range.—In the matter of steam pressure range it was apparent that the manufacturers could without difficulty comply with a requirement of a steam pressure range of 100 pounds to 250 pounds without any changes of the steam nozzle or governor.

Ball Bearings.—Concerning generator ball bearings, it was the consensus of opinion that while no specific sizes could reasonably be recommended it could at least be required of manufacturers to use bearings of standard manufacture and which could readily be obtained in the open market and applied without any difficulty or change in the detail parts of the equipment. In view of the severe service of headlight equipment, which service was generally admitted to be more severe than that of car lighting equipment and which equipment uses a heavy type of ball bearing, it was felt that the manufacturers should use a bearing of sufficient size and ruggedness to withstand the severe service with a minimum amount of trouble or failure.

Brush Sizes.—In the matter of dynamo brushes, discussion developed that a considerable variety of brushes is being used by the various manufacturers, and while it appears to be difficult to bring about a standard for brushes it was felt that the manufacturers should work toward a common standard brush such as that used by the Pyle-National and Buda-Ross companies.

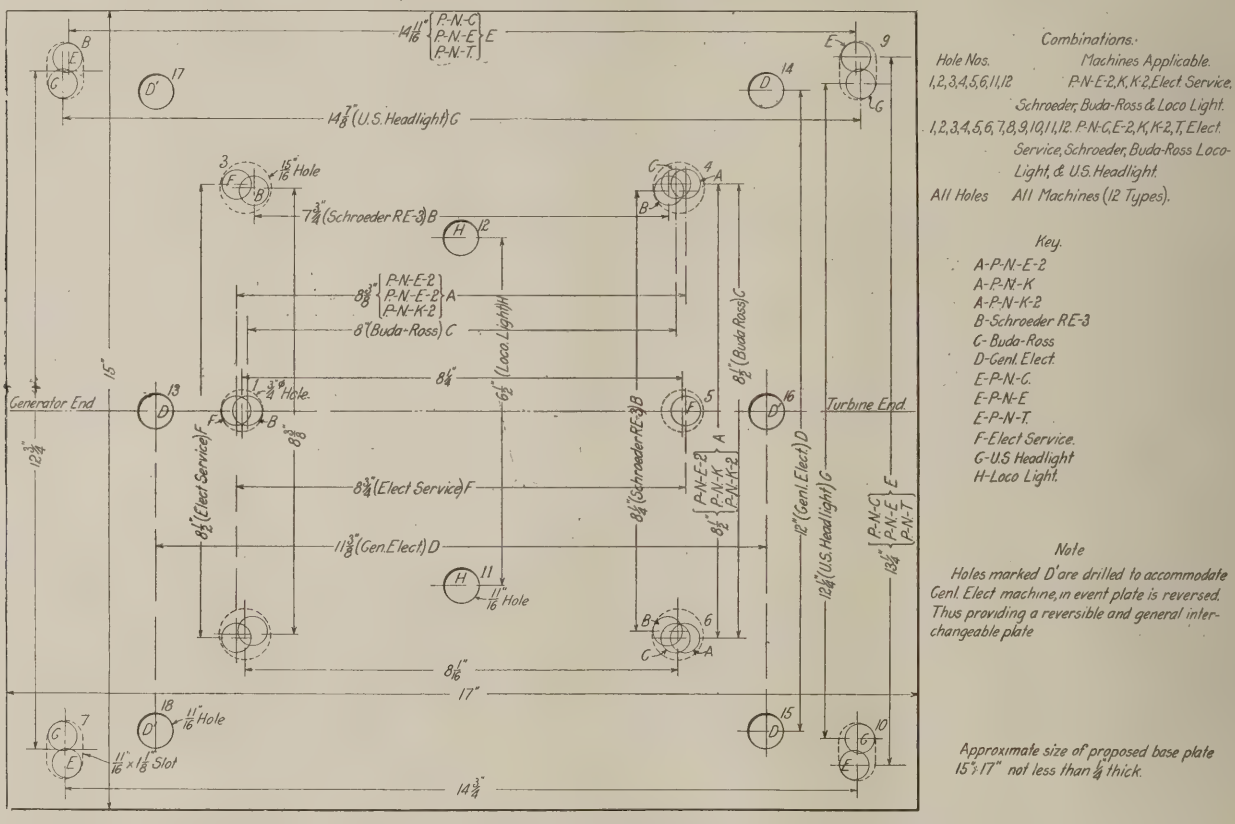


Fig. 1. Proposed Standard Base Plate for Turbo-Generators

Steam Pipe Openings.—Concerning steam pipe and exhaust pipe openings, it was generally agreed that at least ½ in. steam pipe opening and ½ in. drain pipe opening should be provided for as a matter of mechanical strength.

Lubrication.—In the matter of lubrication of turbo-generator set, it developed that a variety of methods of lubrication are used by the manufacturers and while certain designs of equipment apparently will operate with either oil or grease, certain other makes are so designed as to be limited to the use of oil.

Exhaust Head or Muffler.—The matter of an exhaust head or muffler was thoroughly discussed and while there are certain features which might make this a desirable addition to the turbo-generator, such as the elimination of the whistling sound peculiar to operation of a headlight set, it was felt that the matter would involve such an extensive change or addition to the present type of equipment that the advantages to be gained would probably not be worth the complication and addition necessary to incorporate this feature.

At the second meeting of the committee, held at the office of E. W. Jansen, September 15, 1919, the proceedings of the first

meeting were taken up and the subjects discussed at that meeting were gone over with a view to agreement as to recommendations which could be offered by the committee at this convention. The following recommendations therefore are respectfully submitted for your consideration:

Generator Base Plate.—A standard generator base plate so far as outside dimensions and drilling are concerned is recommended, this plate to be approximately 15 in. by 17 in. outside measurement and not less than ¼ in. thick, provided with bolt holes as shown in Fig. 1; this plate being so designed as to accommodate all of the types of equipment represented at the committee meeting of August 25 without any change in the general mounting features. By adding one or two additional holes the plate as designed will be not only interchangeable, so far as the various

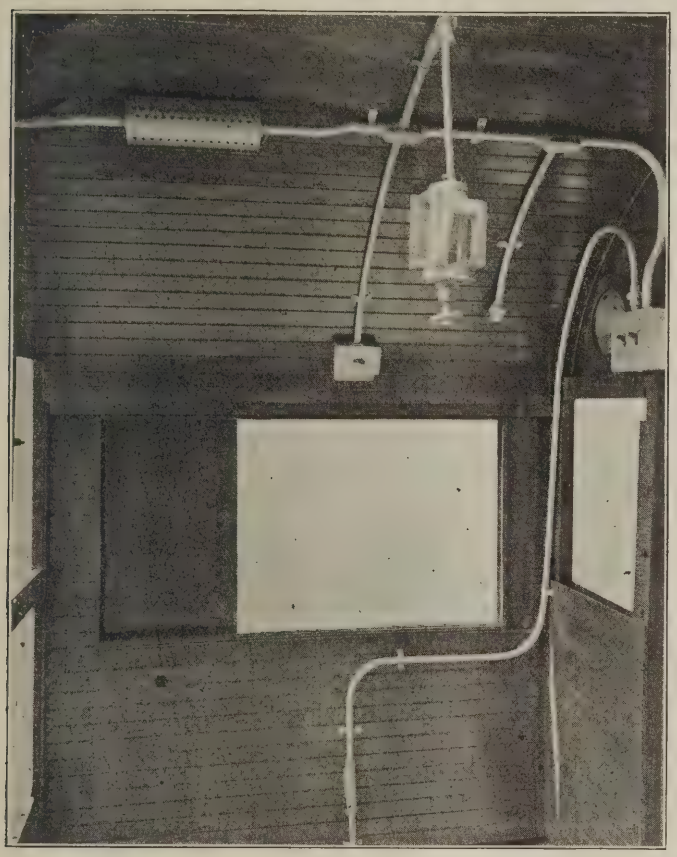


Fig. 2. Arrangement of Conduit for Locomotive Cab

types of equipment are concerned, but can be placed with either end on the right or left side of the locomotive or turned bottom side up and still be in proper position.

If desired by the railroads only such groups of holes as are necessary for particular types of equipment in their service may be provided. The type of generator mounting brackets or other details it is felt should be optional and no recommendation in this connection is made, as it is felt the essential feature is the surface upon which the turbo-generators are mounted and which surface only it is felt should be standard so far as possible.

Steam Pressure Range.—It is recommended that the manufacturers furnish headlight turbo-generator sets of such design and capacity as to operate with practically constant voltage under any load within the rated capacity of the equipment and steam pressure ranging from 100 pounds to 250 pounds boiler pressure without the necessity for change of nozzle or governor parts.

Ball Bearings.—It is recommended that ball bearings of suitable capacity and ruggedness to withstand the severe service peculiar to electric headlight operation be furnished and that such bearings be of standard size and manufacture, which will enable the railroads to obtain bearings for their requirements in the open market if so desired.

Brush Sizes.—It is recommended that the manufacturers work toward a common standard for dynamo brushes, using the Pyle-National and Buda-Ross type of brushes as a possible standard or basis toward which to work. It is further recommended that all brushes be provided with pig-tails of flexible or stranded copper with terminals of round hole, or closed terminal, instead of slotted, or open terminals.

Steam Pipe Openings.—It is recommended that for suitable mechanical strength steam pipe and drain pipe openings in the turbine be standard ½ in. pipe tap. Further, that exhaust be so designed as to have exhaust pipe brought up to a general vertical position.

Lubrication.—It is recommended that turbo-generator set be so designed as to enable the use of either oil or grease for lubrication, sufficient capacity to be provided to properly lubricate bearings for a minimum of one month at one application of lubricant.

Exhaust Head or Muffler.—Requirement of manufacturers to supply exhaust head or muffler for turbo-generator set is not recommended, this to be left optional with the railroads who may desire this feature and to the manufacturers as to their desire or ability to furnish.

General.—In connection with the use of additional accessory lights on locomotives it is recommended that where classification or marker lamps are used that suitable plug and receptacle fittings be used which will insure exclusion of dirt, cinders, moisture, etc., when not in service in order that terminal connections may be in proper condition when required for service.

In addition to the apparent increasing number of lights on locomotives it is the opinion of certain of the members that a turbo-generator of larger capacity than the present 500 watt machine may be necessary to avoid troubles due to overloading and it is recommended that this question be brought up before the association for general discussion.

The illustrations, Figs. 2 and 3, are submitted as a suggestion of the Pennsylvania Railroad in wiring of the locomotive cab in conduit.

Committee: E. W. Jansen (electrical engineer, I. C.), chairman; L. C. Hensel (electrical engineer, St. L. & S. F.); Geo. E. Murrey (electrical and mechanical engineer, G. T.); J. A. Andreucetti (assistant electrical engineer, C. & N. W.); Geo. B. Colgrove (chief electrician, I. C.); H. R. Pennington (supervisor of welding and electrical equipment, C. R. I. & P.); C. R. Sugg (electrical engineer, A. C. L.); J. L. Minnic (electrical

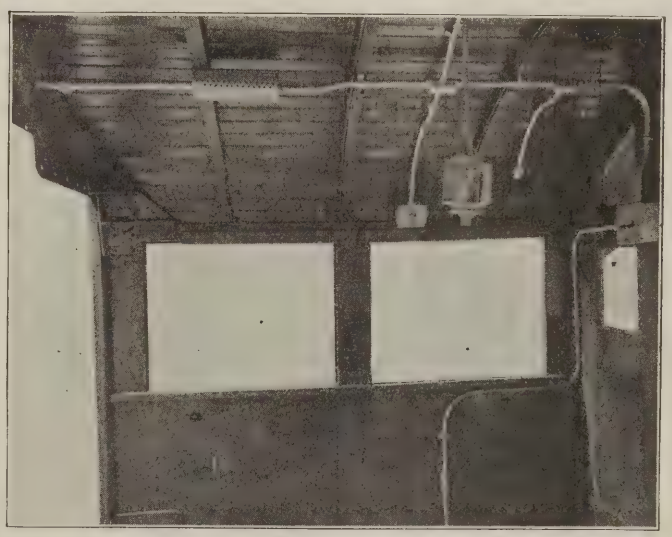


Fig. 3. Arrangement of Conduit with Side Outlet from Switch Box

foreman, Pennsylvania Lines East); C. Watson (chief electrician, C. & O.); L. C. Muelheim (chief headlight supervisor, B. & O.), secretary pro tem.

Discussion

The report of the Committee on Electric Headlights was read by G. B. Colgrove of the Illinois Central. Mr. Minick of the Pennsylvania opened the discussion. He stated that he had nothing to add to the report but that there were two or three things he would like to hear discussed in the matter of the base plate. He said he was inclined to believe that the committee had gone far enough in the matter

and that the cost to manufacturers would be considerable to bring the base plate to a common standard. He thought that new type of equipment would be developed and that he would like to see the association take up the matter and have something accomplished for next year's convention. With reference to ball bearings Mr. Minick said he thought the association should fix the possible minimum standard. He believed that the drain pipe from turbine should be at least ½ in. pipe as the ⅜ in. pipe was very liable to corrode. Mr. Minick expressed himself as favoring conduit wiring for locomotive cabs provided such conduit is installed without cast iron fittings.

In connection with the base plate Mr. Colgrove said that many of the headlight generators now in service would last 15 years. One of the most important things in his opinion was to have the manufacturers plane the feet of the generators to a perfect seat so that no strain be placed on the machine when bolted down. He said that often a generator would run smoothly until the machine was bolted down and that then trouble resulted.

Mr. Billau was in favor of Mr. Minick's suggestion that the association should lay down the specifications for the drilling of the holes in the base plate. He also said that he favored the same thing in connection with ball bearings and that he thought it inadvisable that only one size of bearing should be used but he did think that the number should be reduced as far as possible.

Mr. Quinn of the Norfolk & Western said that in his opinion the question of base plate depended largely upon the depreciation of equipment in service. He cited that one of the best machines on his road had run for 18 years and had every appearance of being good for 18 more. He said it was unfortunate that the need for a standard base plate had not been anticipated but he thought it would be a simple matter to put a dummy base plate on any machine. With reference to the question of drain pipe, he stated that the practice on the Norfolk & Western was to use a ¼-inch copper pipe and that he found this met the situation very well. The matter of lubrication he believed depended very largely on the temperature at which the machine operated and that the operation of ball bearings in grease depends upon keeping the grease in good condition. Referring the question of using conduit in the cabs he said they had been doing so for 19 years, the conduit being installed as an independent unit. He said that standard cast iron fittings had been used but they had not had any difficulty with them.

The question of whether or not a 500-watt generator was sufficient to meet all demands made upon it came up and Mr. Colgrove stated that with all engine lights on the total power and did not exceed 400 watts and that therefore, in his opinion, the 500-watt machine was ample to take care of all requirements.

Mr. Minick said that of course it depended upon the size of lamps used on any particular road, but the mere fact that a simple turbo-generator can be had tends to push the unit into other classes of service, for example on wrecking trains. A 500-watt generator in such a case would be fully loaded to furnish the minimum of service that would be required. Furthermore, he said that on the Pennsylvania Lines another class of service had been suggested for the turbo-generator, namely, that of supplying power for wireless installations on board tug boats. For this service he said about a one kilowatt capacity machine would be required. He also added that there were many places where these units could be added if they had a little higher capacity. On the matter of lubrication Mr. Minick said he did not think that the temperature would be higher than could be taken care of and that in tests made on their equipment which is mounted on the smoke box, a temperature from 180 degrees F. to 200 degrees F. was recorded.

For this service they were able to get an excellent grease. He further stated that he thought the matter of grease should be taken up with the manufacturers with reference to the question of the physical and chemical characteristics of such lubricant.

Mr. Andreucetti said he thought a canvass should be made of the entire situation to determine the best size of generator for all around work.

Mr. Hack of the Southern Pacific called attention to the fact that a machine that normally developed 500 watts could probably do more if required to. In his opinion grease was the proper lubricant to use and he said he thought it was up to the grease manufacturers to work out something along this line.

Mr. Colgrove suggested, in reference to the matter of larger machines, that there were on the market machines of more than 500 watts capacity and did not favor any change in this matter. He further pointed out that in the case of wreckers the boiler capacity was small and that the steam required for operation of a larger turbine would be a disadvantage.

W. L. Bliss of the U. S. Light & Heat Corporation stated that he was interested in the question of lubrication and would like to see the matter turned over to a committee to investigate the matter, so that some specifications could be drawn up to serve as a goal at which to aim. He suggested that analyses could be made and from information obtained specifications could be drafted.

The opinion of E. Marshall of the Great Northern was that the question of temperature was not so much that caused by heat radiating from the boiler as that due to the steam itself. He said it might be possible for the manufacturers to make some satisfactory grease.

Mr. Minick stated that he understood grease could be made that would stand a temperature of 400 degrees F. Mr. Quinn agreed with this but asked what would happen in cold weather to such a lubricant and he thought the problem was to get a grease that would be satisfactory under all conditions.

Mr. Colgrove agreed with Mr. Marshall that the heat of the steam coming into the turbine was the cause of the trouble rather than any heat that might come from the boiler. He stated that his road had used grease that would be all right for a month or so but after that a chemical change seemed to take place which more or less destroyed the lubricating qualities.

S. T. Sikes of the Sunset Central Lines said that he had found in using a stiff grease that the balls were never lubricated and that with a thin grease they became clogged. Under these conditions he found that a good grade of oil gave much better service. His statement was corroborated by Mr. Quinn who said he had found that valve oil was very satisfactory.

Mr. Bouche of the Gould Coupler Company stated that in the experience they had in testing lubricants they had had no satisfaction with grease but that when they tried oil they had excellent success. In no case, he said, had the test been run over three months.

Mr. Haas of the Pyle National Headlight Company said that they had been manufacturing headlights for 18 or 20 years and had used oil for lubrication. Originally the locomotive engineers did the oiling he said, and oil was all right but he believed that more recently the care of headlight equipment had become a shop affair and that for this reason they had investigated and found a grease that was more satisfactory under the changed conditions. He pointed out, however, that oil would give better results because it distributed better at high speed. He believed that the grease should be cleaned out at the end of three

months and further said that the reason for his company advocating grease was on account of maintaining the equipment in the shop and not because they thought grease was best.

Mr. Minick asked why the grease should be cleaned out every three months and stated that their practice was to clean out the grease every nine months. In reply Mr. Haas said it was because it was impossible to be sure that the grease remained in the same condition as it originally was. He claimed that other foreign matter would get in.

Mr. Minick then pointed out that the discussion emphasized the fact that the association had not reached a point where they could adopt standard bearings. He believed that in most cases bearings were too small and that by using larger bearings better lubrication could be obtained.

In connection with the question of foreign substances getting into the grease cellars, Mr. Colgrove thought it might be well to call this matter to the attention of the manufacturers so that the design might be modified in such a way as to prevent these substances from getting into the bearings.

Mr. Jansen asked if any of the members had had any experience in using mufflers on the turbines. In reply Mr. Colgrove stated that he knew of a number that had been constructed which worked very well and apparently offered very little back pressure.

Mr. Shirk of the Great Northern stated that he made a practice of having the exhaust pipe belled out and when this was done he considered a muffler unnecessary. He referred again to the subject of ball bearings saying that he thought the No. 305 bearing was just about on the line and that he favored the No. 507 bearing.

Mr. Andreucetti suggested that the report be accepted as a progress report and have the committee continued. This was put in the form of a motion and it was voted to accept the report in this way.

Handbook for Electric Headlight Maintenance

Committee Proposes to Develop a Book Similar to the Carlighting Manual Issued Last Year

Owing to the amount of work involved in collecting the information desired for the "Locomotive Lighting Handbook," your committee has been unable to complete the work in time for the handbook to be issued at this convention. This book on locomotive lighting has been worked up along the same lines as the handbook on carlighting prepared by the association in 1918. The book will be composed of the following sections:

Introduction.

Description and Illustrations, covering the various makes and types of practically all locomotive lighting, including suburban lighting, equipment manufactured in this country.

Instructions for Operation and Maintenance, of all the various makes and types of locomotive lighting equipment manufactured in this country.

Methods of Installation, as used by a number of the different railroads at the present time, both for locomotive lighting and suburban lighting.

Standard Practice for Conduiting and Wiring, locomotive headlight equipment as recommended by the association.

The instructions for the operation and maintenance are to be checked jointly by the manufacturer and by committeemen who are most familiar with the equipment. At the semi-annual convention at Atlantic City in connection with the work of this committee, it was recommended that the theory of the operation of the equipment should be more clearly explained than has been the practice of such literature in the past—that is, starting with the machine at rest, and describing how the different parts come into play and function as the machine builds up and assumes its duties. This undoubtedly is a good suggestion and if agreeable to the association, efforts will be made by the committee to obtain information of this nature from the manufacture of such equipment.

There has been such an evolution in locomotive lighting since the committee began to collect a large part of the information on the subject; particularly the method for wiring, that the committee is wondering whether or not a great deal of this information may not be more or less obsolete, and to bring this data up-to-date may cause some delay in getting out the handbook. Therefore the committee desires to determine whether it is the opinion of the association that sufficient changes have been made to justify any further delay in publishing this book. The committee refers especially to such additions to locomotive lighting as ordered by the Railroad Administration for the promotion of safety, which calls for all locomotives equipped with electric lights, to be equipped with electric classification lights, and with electric light or lights on the rear of the tender, as may be required by the rules.

The status of the work of the committee to date is as follows:

Practically all locomotive lighting generator manufacturers have furnished descriptive matter and instructions with illustrations covering their representative equipment or equipments. Two or three eastern lines and as many western lines have furnished plans showing methods of installation, together with bill of material for equipping locomotives with electric lighting equipment. Representative roads who operate suburban lighting equipments, have furnished similar information for equipping locomotives and cars for suburban lighting.

This data and information is at the present time in the hands of the secretary and will, on the conclusion of this convention, be compiled together with any other information that members of the association may deem necessary at this meeting. Unless unforeseen delays arise, it is expected that this book will be completed in time to be issued along with the proceedings of the association.

Concluding this progressive report, your committee desires to thank the various manufacturers who have contributed so liberally to the association in producing this handbook, which will undoubtedly be of great value to those having to do with the operation and maintenance of locomotive and suburban lighting equipment.

Committee: H. R. Pennington (supervisor of welding and electrical equipment, C. R. I. & P.), chairman; F. J. Hill (chief electrician, M. C.); C. R. Sugg (electrical engineer, A. C. L.); George E. Murray (electrical and mechanical engineer, G. T. Western Lines); E. W. Jansen (electrical engineer, I. C.); and Joe A. Andreucetti (assistant electrical engineer, C. & N. W.).

Discussion

H. R. Pennington of the Rock Island read the paper on the Electrical Headlight Handbook.

Mr. Gardner raised the question as to whether the publication of the book should be postponed to include new rulings or brought out as it has been compiled at present.

Mr. Buckmaster of the Baltimore and Ohio wanted to know in case the book was brought out in its present form what plans had been made for succeeding items that might eventually be required. In reply Mr. Pennington stated that no provision had been made for these.

Mr. Andreucetti, of the Chicago and Northwestern, said it had been the idea of the committee to get out the book along the same general lines as the car lighting handbook and that such a book would take care of the conditions during the next few years and that then the book could be revised. He was not in favor of publishing the book in any sort of loose leaf form. There are many disadvan-

tages to this form of book since it is to be used by the maintainers of headlights, the pages might easily become lost or torn and in some instances perhaps new sheets with latest information might fail to be inserted. The committee believed the plan they had to be the logical one but encouraged discussion so that accepted suggestions might be included and the book published within a few months. The book is to be a simple treatise on locomotive headlight equipment as it is today. The general opinion seems to be that the sooner the books were placed in the hands of the headlight maintainers the better, since practically all roads had begun the use of electric headlights and the need for some source of trustworthy information was beginning to make itself felt.

J. R. Sloan of the Pennsylvania seemed to think that the value of the book would be greatly increased if it contained a catalogue of the various parts of the headlighting equipment and that without such catalogue the book would be incomplete. He felt that unless such a section were included that different men would be calling the same parts by various names and that much confusion might arise. Mr. Sloan was in favor of having the theory of operation of each equipment included in the book.

In reply to Mr. Sloan, Mr. Andreucetti stated that the idea was not to make the book a catalogue and that the manufacturers would see that the various parts of equipment were properly named and numbered in their respective catalogues. Furthermore, the inclusion of such information would make the book more bulky and complex and that it was considered better to eliminate anything in the nature of a catalogue.

L. D. Moore, of the Missouri Pacific, said that by all means a description of the theoretical operation of each type of equipment should be included since the man on the job generally takes more interest if he knows the relation of parts to each other and the cause of this relation.

Mr. Sloan made the suggestion that some blank pages be included in the book so that those using it could make their own notations.

C. P. McGinness, of the Pyle National Headlight Company, said he felt that any such a book would be incomplete without a good general index. In answer to Mr. McGinness' statement Mr. Andreucetti stated that the committee had asked each manufacturer to turn in a complete index for his particular equipment. This had been done by some of the manufacturers. Mr. McGinness' point was that a general index should be included which would combine the similar features of the several different kinds of equipment. Mr. Sloan then made the statement that it was the committee's idea to make a general index to cover the book.

The opinion of the majority was in favor of an early publication of the book to include the information at hand also the new work on classification and marker lights but to exclude any catalogue section. With these conditions the report was accepted.

Sample Electric Headlight Report Forms Submitted

Forms Provide for Operation and Maintenance Records Which Can be Exchanged Between Railroads

Your committee has had several meetings, and has considered submitting sample forms as recommended practice for the use of the railroads in keeping actual records of their costs of operation and maintenance of electric headlights, with the idea that if such information is to be exchanged between the different railroads, it would then be comparable on account of having been drawn up on the same or practically the same form.

Copies of the forms suggested follow:

Committee: E. W. Jansen (electrical engineer, I. C.), chairman; L. C. Hensel (electrical engineer, St. L. & S. F.); Geo. E. Murrey (electrical and mechanical engineer, G. T.); J. A. Andreucetti (assistant electrical engineer, C. & N. W.); Geo. B. Colgrove (chief electrician, I. C.); H. R. Pennington (supervisor of welding and electrical equipment, C. R. I. & P.); C. Watson (chief electrician, C. & O.); L. C. Muelheim (chief headlight supervisor, B. & O.), secretary pro tem.

Electric Headlight Report—Operation

.....19..

Division	Equipment	Carbons	Brushes	Lamps 250W	Lamps 15W	Oil Qts.	Material	Avg. Mat'l	Labor	Avg. Labor	Total	Avg. 19..
....	....	....	....	....		....	....	....	....	....	....	....
....	....	....	....	....		....	....	....	....	....	....	....
....	....	....	....	....		....	....	....	....	....	....	....
1st District Avg. Total	....	....	....	....		....	....	....	....	....	....	....
....	....	....	....	....		....	....	....	....	....	....	....
....	....	....	....	....		....	....	....	....	....	....	....
....	....	....	....	....		....	....	....	....	....	....	....
2nd District Avg. Total	....	....	....	....		....	....	....	....	....	....	....
System Avg. Total	....	....	....	....		....	....	....	....	....	....	....

Office of.....
Date.....

Electric Headlight Report—Maintenance

.....19..

Division	Equip-ment	Arma-tures	Material	Average Material	Labor	Average Labor	Total	Average .....19..
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
1st District Avg. Total	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
2nd District Avg. Total	.....	.....	.....	.....	.....	.....	.....	.....
System Avg. Total	.....	.....	.....	.....	.....	.....	.....	.....

Office of.....
Date.....

Electric Headlight Report—Maintenance and Operation, December, 1918

Division	H'dlights in Service	Material	Average Material	Labor	Average Labor	Total	Average Dec., 1918	Average Dec., 1917
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
1st District Avg. Total	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....
2nd District Avg. Total	.....	.....	.....	.....	.....	.....	.....	.....
System Avg. Total	.....	.....	.....	.....	.....	.....	.....	.....

Note: Under next to last column "Average" show month and year, and last column show at the top same month preceding year.

Office of (Gen. Supt. Motive Power)
Date.....

A. B. C. Railroad—Report of Cost of Handling Electric Headlight Equipment

Division..... Month of.....

MAINTENANCE

No. of Engines Equipped	No. Armatures Used	Cost of Material Used in Repairs	Cost of Labor Used in Repairs	Total Cost of Repairs

OPERATION

No. of Carbons Used	No. of Electrodes Used	No. of Brushes Used	No. of Globes Used 250W	15W	No. of Qts. of Oil or Grease Used	Cost of All Material Used in Operation	Cost of All Labor Used in Operation	Total Cost of Operation

.....
Master Mechanic

Instructions: This report will be made monthly for each division and forwarded to reach the Electrical Engineer not later than the 25th of the month succeeding that for which the report is submitted.

A. B. C. Railroad—Report of Electric Headlight Failures

Location ..... Date..... Division..... Engine No.....
Train No..... Make of equipment..... Type..... Style.....
Did equipment failure result in engine failure..... Was train delayed.....(If so how long delayed)
..... Time of failure..... Out of service how long.....
Cause of failure.....
Defective parts causing failure.....
Nature of work performed.....
Signed .....Title .....

Instructions: This report will be made in duplicate, one copy to be sent to the Electrical Engineer....., and one copy to the Master Mechanic. Report to be made for each headlight failure even though it did not result in train delay or engine failure.

Discussion

Mr. Jansen of the Illinois Central read the report of the committee on compiling costs for maintenance of headlight equipment. He stated that the first four of the forms given in the report were to be made out monthly.

The question arose as to how the cost of work done on engines that were shopped was to be billed to the division from which the engines came. In answer to this Mr. Sloan said that he understood that the forms as prepared were intended merely to represent the amount of work done in each shop—that they simply showed the work done during the month by each individual shop. Mr. Jansen stated that this was what had been intended.

Another question that came up was whether or not headlights and classification lights were to be taken together. It was pointed out in the first form that under the heading of lamps that both 250-watt and 15-watt lamps were mentioned, indicating that the entire electrical equipment of the locomotive should be included in the reports.

Mr. Andreucetti said that it was his understanding that the report was a recapitulation of all the equipment on any one division and that it covers the material used in maintaining the equipment. He further stated that the object of report was to arrive at the average cost of engine material used.

It was finally concluded to refer the report to a letter ballot.

Electrification Investigation Form and Bibliography

Information is Given Which Will Greatly Assist Any Road in Making a Comprehensive Investigation

Your Committee, after very careful consideration of this most important subject, has decided that it could be of more service to the management of the various railroads by compiling a typical skeleton form for an electrification report—this form to serve as a guide in procuring all data necessary to an intelligent and comprehensive conclusion and recommendation, together with an index of all valuable papers, etc., referring to the steam railroad electrification subject.

The data and skeleton form of report herewith:

Section 1—Investigation and Report

General Introduction

Broad general statements covering:

1—Particular problem being investigated.
2—Territory and traffic considered and affected.
3—Traffic chart showing origin and destination points of this traffic, as well as general nature of traffic.
  a—Passenger—through—suburban.
  b—Freight, coal or ores, grains, provisions, iced stuffs, general merchandise, etc.
4—Reasons for considering electrification.
5—General changes in operating conditions by reason of electrification, engine runs, engine handlings, train runs, crew runs, engine houses, shop facilities, road facilities, etc.
6—Total capital required.
7—Capital retired.
8—Net new capital required.
9—Gross annual saving or deficit in dollars.
10—New capital account changes.
11—Net annual saving, making a net return of ——% on new capital required.
12—Therefore electrification desirable or not desirable.
  a—Operating viewpoint.
  b—Financial viewpoint.

I. The Territory:

1—Small scale general maps.
2—Large scale maps showing track facilities and tracks considered for electrification in yards, terminals, at industrial exchanges, points and sidings, and at all special places, i. e., around shops, etc.
3—Number of main line and running tracks.
4—Yard tracks, running, classification, storage, new yard facilities, if any, for interchanging from steam to electric power at ends of electrified zone.
5—Sidings, turnouts, spurs, cross-overs, etc.
6—Road miles.
7—Main line track miles.
8—Total track miles, including yards, sidings, etc.
9—Profiles showing:
  a—Grade section.
  b—Average actual grade in each section.
  c—Average compensated grade in each section.
  d—Maximum actual grade in each section.
  e—Maximum compensated grade in each section.
  f—Average curvature in each section.
  g—Maximum curvature in each section.
  h—Scale of miles.
  i—Location of stations, signal towers, tunnels, and other significant structures.
  j—Elevations top rail at each point of change in average grade, i. e., grade section boundaries.
  k—Ruling grades in each direction of traffic and grade section and point at which each occurs. (Average grades to be compensated for curvature in each direction of

traffic, both positively and negatively, on account of calculating regenerative braking effect.)

II. The Traffic:

A. Freight:

1—Data showing average daily traffic by months and rate of growth from year to year.
2—Data showing maximum daily traffic each year and season at which it occurs, and rate of growth from year to year.
3—Establish yearly traffic factor as maximum day per year divided by average daily traffic over same year, and determine curve of this function so as to predict for future from past.
4—Determine all the above in cars, trains, tonnage. Determine functions showing increasing car loading and increasing train loading in tonnage from year to year.
5—Plot all the above.
6—Show by tabulation or plots the number of days each year upon which the traffic exceeded certain amounts; these amounts to be taken in equal small increments from the average daily traffic per year to maximum daily traffic per year.
7—From a study of all the above, determine traffic basis upon which to base:
a—Load curves.
b—Requirements in electrical facilities, including locomotives.
c—Economies or losses over steam operation (a, b and c not to appear here, but later).
8—Thoroughly analyze the traffic basis chosen under 11-A-7 into:
a—Cars, empties and loads.
b—Trains.
c—Tonnage.
d—Preference and slow freights.
e—Classify a, b, c and d into through and local.
f—Further classify as to origin and destination where such are within electrified territory.
g—Plot train charts of actual steam operation.
h—Plot train charts of proposed electric operation. (Before this can be done, the system of electrification and type and characteristics of locomotive will have had to be decided, although not to be mentioned in report till later.)
i—Develop time saving in car days of electric over steam operation.
j—Develop increase in road capacity in ton miles per day over limit of steam operation by reason of electrification.

B. Passenger:

1—Plot schedule of actual steam operation.
2—Plot schedule for proposed electric operation if different.
3—In suburban sections, study traffic growth and characteristics over the years.
4—Show trains converted to M. U. trains.
5—Develop data from which to estimate change in riding habit due to electrification.
6—Collect data showing growth of suburban sections and probable effect on that growth of electrification.
7—Determine usual number of cars and tonnage on all trains.
8—Note prevalence of special trains, second sections, extras, etc. (3, 4, 5, 6, 7 and 8 must be determined before 1 and 2, but are to be offered in explanation of 1 and 2, already presented.)

C. Yard, industrial, pick up, etc.:

1—Study conditions in yard, shifting and classification. If to be done electrically, determine conditions, lengths of trains to be handled over humps, etc.
2—If regular crews and steam locomotives are assigned to industrial sidings for shifting, etc., or as pick up crews, determine this traffic and investigate its nature.

D. Work trains:

1—Determine work trains necessary and facilities required.

E. Railroad coal:

1—Determine coal haulage in train miles, car miles and ton miles, which will be eliminated by electrification, taking proper account of loading points of steam locomotive tenders over the electrified zone, including coal on tenders of locomotives.
2—Determine new coal traffic, if any, established to power plant by reason of electrification.

III. The System:

1—Consider problem from all angles, both present and future. (It is assumed load curves have been worked up, although not mentioned till later.)
a—Current requirements in trolley and at switching centers with various systems and at various voltages.
b—Possibilities of utilizing some power source already available and practicabilily of same.
c—Further extensions of electrified zone, most economical type of power, transmission, voltage, etc.
d—Physical clearances limiting trolley and third rail collection, if any.
e—Operating and maintenance forces for various systems.
f—Types of locomotives available.
g—Physical limitations on sub-station location and spacings, and on transmission line voltage, etc.
b—Inductive disturbances, electrolysis effects, corona, storms, lightning, etc., non-interruption of traffic.
i—Line and collector copper.
2—Make choice of system, voltage at collectors, voltage on transmission line, frequency, phase, etc., and state reasons.
3—Develop system wiring diagrams (consider under power plant and sub-stations).

IV. Locomotives:

1—Types of electric locomotives (freight, passenger, shifting) chosen.
2—Full data on them, weights, speed, operating characteristics, control, mechanical and electrical descriptions, especially of new features.
3—Photographs and full curves.
4—Comparison with steam locomotives displaced in:
a—Weights.
b—Speeds.
c—Control.
d—Reliability.
e—Proportion of time on road.
f—Effect of weather on.
g—Necessity for inspections and handlings.
h—Necessity for shopping.
5—Tabulations of tonnage rating of freight and passenger electric locomotives over electrified zone.
6—Tabulations of tonnage rating of steam locomotives over same zone and over adjacent divisions on each side of electrified zone if these divisions are still steam operated.
7—Comparison of electric locomotives with other electric locomotives in weight economics, hauling power, etc.

V. Energy requirements:

1—From train charts previously plotted for traffic basis, calculate and plot 24-hour load curve corresponding to this traffic basis.
2—Determine possible heavy loads and extent of their duration for possible congested movements following wrecks, tie-ups, etc.
3—From relation established between traffic basis chosen and average yearly traffic for year under consideration, and from 1 and 2, determine:
a—Average yearly load.
b—Instantaneous yearly max.
c—15 min. yearly max.
d—Hour yearly max.
e—Yearly load factors—b, c, d.
f—Where traffic varies considerably with the seasons, determine the same as b, c, d, e for each month of season.
g—Correct all of the above for regenerative effect, also to be determined from train charts. (All of the above energies to be at power plans bus, proper efficiencies between train and bus having been determined. Don't forget accelerating currents.)
4—It may be wise to impose certain restrictions on traffic

under electric operation so as not to really interfere with operation, but to limit the max. peak loads. If so, state the restrictions.

5—It is well to plot the freight, passenger, yard and shifting loads, and M. U. load where heavy, separately as well as total load curve. These curves are highly useful in analysis, especially in improving load factor and operating conditions.

VI. The power plants:

1—If power is not to be purchased, show why and proceed to find location for power plant where facilities are suitable to the kind of plant proposed.
2—Where adequate water power not requiring large development expense in dams, etc., is available, use.
3—Where not, locate steam station where there is sufficient condensing water and facilities for handling coal, etc.
4—From study of load curve and from system and transmission, voltage chosen, etc., develop station:
a—Size and number of generating units.
b—Size and number of boilers.
c—Size, number and kind of exciters.
d—Auxiliaries, coal and ash handling, etc.
e—Switching and control of protection (very thoroughly).
f—Transformers.
5—From load curves now determine a generating unit operating schedule.
6—Determine power plant forces.
7—Determine coal and water rates over year.
8—Determine emergency operation, etc.
9—Produce maps, photographs and drawings showing whole location and layout.
10—Where condensing water is scarce, determine stream flows, water temperatures and barometric conditions throughout the years, then consider cooling scheme best applicable, i. e., impounding dam, spray pond, etc.
11—Further consider III—3. Modify if necessary.

VII. Transmission lines:

1—Develop and survey right of way, having due regard to sub-station locations mentioned later, and ability to properly patrol line.
2—Study atmospheric conditions, corona, lightning, etc.
3—Determine construction, wire spacing, insulation, towers, etc., mechanical and electrical.
4—Line regulation, losses, surges, etc.
5—Factor of safety against mechanical and electrical failure. Road must not be tied up.
6—Control and protection. Voltage, phase, etc., was chosen under III.)
7—Further consider III—3. Modify if necessary.
8—Maps and drawings of towers, etc.

VIII. Sub-stations:

1—Final determination of sub-station locations from standpoint of:
a—Regulation (voltage).
b—Economy.
c—Inductive and electrolytic disturbances.
d—Control.
e—Physical possibility of location. (See III—1—g.)
2—Determination from load curves and from system and from sub-station locations of load curve for each sub, peak and congested loads, etc.
3—Determination of sub-station capacity, size, type units, etc., water cooled, self-cooled, indoor, outdoor, regard to weather conditions.
4—Short-circuit currents, control, relay protection, oil switches (very important), lightning protection, non-interruption of traffic under all conceivable emergencies, induction and electrolysis.
5—Design sub-stations.
6—Maps, drawings, load curves, tabulations, etc.
7—Determine sub-station, operating forces and maintenance forces.
8—Further consider III—3. Modify if necessary.

IX. Collection structure:

1—Catenary or third rail in agreement with choice made under III.
2—Surveys to determine foundations along right of way. Physical clearances to buildings, rock cuts, bridges, tunnels, telephone and telegraph lines, between main line and sidings, signal towers, etc. All cuts, fills, and complete data on same noted and located. Locate all P. C.'s and P. T.'s and degrees of curvature, all P. S.'s, sidings, turnouts, station platforms and sheds, coal wharfs, tipples, water plugs, track tanks, signal bridges, or standards, crossings (public and private), wire crossings, streams, bridges and culverts, etc.
3—Locate catenary bridges. Attention to spans on curves.
4—Provide anchor bridges at signal bridges.
5—Thoroughly design structure, mechanically and electrically.
6—Attention and special design for places of restricted clearances.
7—Sectionalization, protection of cross-overs, etc., max. continuity of service.
8—Rail bonding.
9—Signal and special bonding.
10—Complete III—3.
11—Figure short-circuit currents final. Again examine sub-station switching for ability to withstand short-circuit bumps and for relay protection to isolate disturbances.
12—Figure voltage regulation for normal and congested loadings. Design of distribution system must keep this within limits. Inductive and other disturbances controlled by sectionalization design and sub-station location and design.
13—Protections to trespassers from high voltage.
14—Consider station and other lighting and power uses, signal sets, etc.

X. Other facilities:

1—Track tanks, air compressor stations, tunnel ventilating stations, engine houses, inspection pits, work trains, sidings, facilities for transferring and changing power from electric to steam, etc.
2—Telephone, telegraph, signal lines, etc.
3—Electric energy for shops, etc.

XI. General operation:

1—Departures from and changes in steam practice.
2—Locomotive and crew schedules.
3—Revision of runs outside of electrified territory due to changes in electrified territory.
4—General operating organization. Chart of same.
5—Locomotive inspections, shoppings, etc., number of locomotives required, number of steam locomotives released, etc.

XII. Cost of electrification and resulting economics:

1—General basis of financial estimate as developed in all of the foregoing.
2—Cost, capital account.
a—Detailed itemized estimates on power plant, transmission line, sub-stations, catenary structure, other facilities and changes.
b—Summary complete statements:
1—Catenary structure, bonding, feeders, clearance changes.
2—Signal changes.
3—Transmission line.
4—Sub-stations.
5—Electric locomotives and M. U. cars:
Freight
Passenger
Shifting
6—Other facilities, new, required by electrification and electric operation. Total—not incl. power plant.
7—Credit to steam locomotives released:
Freight
Passenger
Shifting
8—Credit to facilities required to handle same, expansion in steam traffic as assumed for determining electrical facilities. (Locomotives, additional engine house facilities, turntables, water and cooling stations, etc.)
9—Credit to abandonment of actual existing steam facilities replaced (not incl. locomotives), pumping

stations, water and coaling stations, engine house, turntables, etc. Net, not incl. power plant.
10—Power plant. Net, new capital, incl. power plant. Total capital, incl. power plant and no credits (gross).

3—Annual expenses to steam operation eliminated by electric operation.
a—Detailed itemized statements and tabulations on steam coal consumption, loading points, costs, crew expenses, steam operation minus electric operation, engine house expense, locomotive handlings, other expenses shown needing classification.
b—Summary complete statement.
1—Crew expense.
2—Coal, incl. haulage, handling, etc. Replace R. R. coal traffic with revenue tonnage and add net income of same, since this tonnage appears on both steam and electric train charts. Deduct tonnage for power plant coal.
3—Steam locomotive repairs.
4—Oil and supplies.
5—Engine house expense.
6—Main line ash pit service.
7—Depreciation on book value facilities abandoned.
8—Depreciation on book value facilities not required to meet expansion in steam traffic equal to expansion for which electric facilities are provided.
9—Saving due to speeding up traffic movement.
10—Saving due to increasing capacity for traffic of existing track facilities.
11—Saving in brake equipment maintenance due to regenerative braking.
12—Operation and maintenance of steam operating facilities abandoned, pumping stations, etc.
13—Extra track maintenance under steam operation, ballast cleaning, etc., especially at track tank stations.
14—Saving in structural maintenance due to soot elimination, signal bridges, etc.
15—Saving in shop expenses.
16—Any other savings by reason of special conditions.
c—Tabulation of steam locomotive mileage eliminated:

Freight, Passenger, Shifting } Total.

4—Annual expenses to electric operation:
a—Detailed itemized statements and tabulations on cost of electric energy, transmission line, sub-station and catenary and bonding maintenance, inspection and maintenance on electric locomotives and M. U. cars, cost of electrical energy at power plant to include fixed charges, cost of electrical energy to be net after considering regeneration.
b—Summary complete statement:
1—Interest (net new capital less power plant). (Power plant capital charges incl. under cost of energy at power plant.)
2—Insurance and tax accounts on same.
3—Description (total capital less power plant).
4—Cost of electrical energy, incl. plant capital charges.
5—Transmission line maintenance.
6—Sub-station maintenance and inspection.
7—Catenary structure maintenance.
8—Electric locomotives and M. U. cars—inspection, repairs, maintenance, engine house expenses, oil, supplies.
9—Any other expenses to electric operation by reason of special conditions.
c—Tabulation of electric locomotive mileage:

Freight, Passenger, Shifting } Total.

5—Balance:
1—Annual expenses to steam operation eliminated.
2—Annual expenses to electric operation.
3—Net annual saving: 1, 2.
4—Net return on net new capital.
5—Annual expenses to steam operation eliminated not incl. capital charges.
6—Annual expenses to electric operation not incl. capital charges.
7—Gross annual saving: 5, 6.
8—Gross return on gross new capital.
9—Net annual capital charge (net new capital).
10—Net annual depreciation account (net new capital).
11—Annual interest on 10 at 5%.
12—Total value of account 10 at end of 20 years, interest compounded annually at 5%.
13—Excess of 12 over net new capital at end of 20 years.

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Electrification of the Arad-Hegyaljaer Railway; equipment of a short line through a fruit country in Hungary.

Montreal and Southern Counties Railway. 1914. (In Electric Railway Journal, Mar. 28.)

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Parodi, H.

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A preliminary description of this suburban electrification, its novel features, including the use of standard steam railroad passenger coaches electrically equipped, and a new form of overhead construction.

Pontecorvo, L.

Results of the electrification of a congested Italian line. 1914. (In Railway Age Gazette, July 17.)

A line with very heavy grades and long tunnels on which the capacity was increased 100 per cent.

Pontecorvo, L.

Tripling the capacity of the Italian Giovi line by electrification. 1914. (In Electric Journal, Oct.)

A statement of the results obtained.

Potter, W. B.

Developments in electric traction. 1914. (In General Electric Review, Nov.)

States problems of steam road electrification, requirements of design in electric motors and locomotives and reviews some of the factors governing the choice of higher d. c. voltage for heavy traction work.

Potter, R. R.

Operation of the single-phase equipment of the New York, Westchester & Boston Railway Company. 1914. (In Elec. Journal, May.)

Report of the operation during 19 months, with costs.

Report of the Swiss Electrification Commission. 1914. (In Electric Railway Journal, Mar. 7.)

Compares the several systems and gives reasons for favoring single-phase operation; from "La Luniere Electrique."

Ripley, Joseph P.

Electrification of heavy mountain grades. 1914. (In Railway Age Gazette, Feb. 13.)

Summary of a report, showing the proposed electrification of the Raton Mountain on the Santa Fe is found to be unprofitable.

Ripley, Joseph P.

Electrification of heavy mountin grades. 1914. (In Railway Gazette, July 31.)

Brief summary of a report on the electrification of the 23-mile

High-speed electric passenger locomotives. 1914. (In Railway Age Gazette, Mar. 6.)

Illustrated description of electric locomotives designed to haul five steel passenger cars, weighing 187.5 tons, at a speed of 56 m. p. h. on a level tangent with 1100 volts direct current.

High speed passenger locomotives, electric locomotives for the Oakland, Antioch & Eastern Ry. 1914. (In Railway Master Mechanic, Apr.)

Holy, G. H. F.

Standardization of electric locomotives. 1914. (In Electric Journal, Oct.)

Information concerning these standard locomotives and their performance.

Hubar-Stockar, E., C. O. Mailloux and others.

Electrification of railroads; discussion at the tenth annual electrical night of the New York Railroad Club. 1914. (In Proc. New York Railroad Club, Mar. 20.)

Kilchenmann, Bruno.

Results obtained with electric traction on the Simplon Railway. 1914. (In Bulletin, International Railway Congress, April, 1914.)

Examines the advantages and disadvantages which seven years' experience has shown to exist in the power stations, contact lines and electric locomotives.

Kilchenmann, Bruno.

Working experiences of electric traction in the Simplon Tunnel. 1914. (In Electrician, Jan. 2.)

Account of difficulties encountered and overcome; abstract of article in Elek. Kraft. und Bahnen.

Kummer, W.

Das Zugforderungsmaterial der Elektrizitätsfirmen in der Schweiz. Landausstellung in Bern, 1914. (In Schweizerische Bauzeitung, Sept. 11. Serial, 1st part.)

Motive power equipment of the electrical firms at the Berne Exposition in Switzerland; description of a series of locomotives, etc.

Kummer, W.

Ueber Triebwerkbeanspruchung bei elektrischen Lokomotiven, mit besonderer Berücksichtigung des Kurbelantriebs. 1914. (In Schweizerische Bauzeitung, Mar. 14. Serial, 1st part.)

The driving gear of electric locomotives; a mathematical study of forces involved.

La Chapelle, L.

Les transformations du réseau de banliene des chemins de fer de l'Etat. 1914. (In Technique Moderne, July 15.)

Changes to conform with system of electrification adopted by the Compagnie de l'Ouest.

Lancaster, W. C.

Canadian Northern tunnel and terminal electrification. 1914. (In General Electric Review, Nov.)

Describes the nature of the work, discussing why 2400-volt d. c. was selected.

Lancaster, W. C.

Electrification of the Canadian Northern Montreal tunnel and terminal. 1914. (In Electric Railway Journal, Mar. 14.)

The 2400-volt direct current system was chosen as most economical for a combination of trunk line locomotive and suburban motor car service.

Lebenbaum, Paul.

Electrification of Southern Pacific Company's lines out of Portland, Ore. 1914. (In Electric Traction, May.)

Map and illustrated description of the two lines running south from Portland to Whiteson.

Locomotives on the Rhaltian Railway. 1914. (In Electric Railway Journal, June 27.)

Illustrated description of the single-phase locomotives for the leading narrow-gauge line of Switzerland, equipped with series type motors and voltage step control without contractors.

London and North Western Railway electrification. 1914. (In Tramway and Railway World, May 7.)

Illustrated description of the West London section placed in operation, May 1.)

London electrification schemes. 1914. (In Railway Gazette, Aug. 14. Serial, 1st part.)

Reviews the work in progress.

Lydall, F.

Motor and control equipments for electric locomotives. 1914. (In Journal, Institution of Electrical Engineers, Feb. 26.)

Considers motor capacity, and the influence of the weight of

section near Trinidad on the A., T. & S. F. Ry.; maps.

Santoro, F., and L. Calzolari.
Practical results of railway electrification in Italy. 1914. (In Engineer, Jan. 23. Serial, 1st part.)
Study of the advantages which have resulted from the electrification of the Giovi line and a history of the undertaking.

Sauvage, Paul.
La traction electrique et le systeme de traction auto-regulateur. 1914. (In Memoires Societe des Ingeneurs Civils de France, Feb.)
Electric traction and the automatic regulator system of traction; application to continuous current and single-phase systems.

Shaw, J. A.
Steam railway electrification. 1914. (In Canadian Engineer, July 9.)
Discusses the single-phase alternating current, and the 2400-volt direct current; abstract of paper read before the Canadian Electrical Association.
Single-phase locomotives for the Rhaltian Railway. 1914. (In Engineer, July 17.)
Describes locomotives built for this railway by the Oerlikon Company.

Smith, Roger T.
Some railway conditions governing electrification. 1914. (In Journal, Institution of Electrical Engineers, Feb. 12.)
Discusses the question of electrification for suburban, fast passenger and goods service.

Spinelli, Francesco.
Electric traction on the Italian State Railways: Lecco-Monza line. 1914. (In Tramway and Railway World, Dec. 10.)
Detailed description of a very successful development.

Sprague, Frank J.
Possibilities of an electrical commission. 1914. (In General Electric Review, Nov.)
A plea for steam railroad electrification, pointing out the financial and economic aspects of the problem.

Thormann, L.
Die elektrische Traktion der Berner Alpenbahn-Gesellschaft, 1914. (In Schweizerische Bauzeitung, Jan. 10. Serial, 1st part.)
Electric traction on the Bernese Alps Railway, Bern-Lötschberg-Simplon; first part briefly describes line, and starts a description of the electric locomotives in use.
Three thousand-volt d. c. electrification of the Puget Sound lines of the Chicago, Milwaukee & St. Paul Ry. 1914. (In Electric Traction, Dec.)
Describes work about to be undertaken, which must overcome many difficulties.

Uytborck, E.
Notes on the electrification of the French Midi Railway Company. 1914. (In Bulletin, International Railway Congress, July.)
Shows the importance of the electrifications which have been carried out and are proposed.

Vallauri, Ricardo.
Einiges uber die Systemfrage bei der Elektrisierung der Hauptbahn-Einphasenstrom und Gleichstrom. 1914. (In Elektrische Kraftbetrieb und Bahnen, Aug. 24.)
The question of system in the electrification of main lines single-phase and direct current; choice of system, motor, locomotive, etc.

Wichert, A.
Ueber den Einflus des Lagerspiels bei Kurbelketrieben elektrischer Lokomotiven. 1914. (In Elektrische Kraftbetrieb und Bahnen, June 14.)
The effect of bearing play in crank-driven electric locomotives; mathematical.

Winship, L. C.
The electrified Hoosac Tunnel. 1914. (In Electric Journal, Oct.)
Explains conditions which led to the electrification, and considers some features peculiar to tunnel operation.

Zolland, F.
Electrification of the Riksgränsen Railway. 1914. (In Electrician, Oct. 9.)
Describes a mineral line in the north of Sweden where the working conditions are very severe.

Zolland, F.
Elektrisierung der Riksgränsbahn. 1914. (In Elektrische Kraftbetrieb und Bahnen, Mar. 24. Serial, 1st part.)
Electrification of the Riksgränsen Railway; details of the power plant, transmission line, etc., of the most northern electric railway of the world in northern Sweden.

Year 1913

Alexanderson, E. F. W.
Single-phase motor car equipments for trunk line service. 1913. (In General Electric Review, May.)
Explains the principles of the single-phase commutator motor and the theory, design, mechanical construction, electrical characteristics and operation.

Alexanderson, E. F. W.
The split-phase locomotive, 1913. (In General Electric Review, Oct.)
Describes and explains features of control of this novel type of electric locomotive.

American Railway Engineering Association.
Report of Committee on Electricity. 1913. (In Bulletin, American Railway Engineering Association, Mar.)

Armstrong, A. H.
Engineering problem of electrification. 1913. (In Trans. Canadian Society of Civil Engineers, Dec. 18.)
Discussion of engineering questions entering into the electrification problem as having a bearing on all important matters of first cost and cost of operation.

Armstrong, A. H.
Steam railroad electrifications. 1913. (In Electric Railway Journal, Jan. 4.)
Discusses mountain grade service and shows the economy of electric locomotives.
Articulated electric locomotives for the New York Central. 1913. (In Railway Age Gazette, Apr. 11.)
Illustrated description of the eight-motor articulated 600-volt direct current electric locomotives placed in service.

Aspinwall, L. M.
Selection of electric locomotives. 1913. (In Electric Journal, Oct.)
Considers the characteristics required for different classes of service.

Babcock, Allen H.
Mountain railway electrification; a study of the Tehachapi Pass. 1913. (In Proceedings, Amer. Inst. of Elect. Engrs., Sept.)
Study of the relative merits of steam and electrical equipment.

Batchelder, A. F.
Forces in electric locomotives influencing wheel flange and track wear. 1913. (In General Electric Review, Nov.)
Aims to show how, by constructing a four-axle locomotive with two trucks connected by a huge joint, the forces which tend to affect the wear are lessened.

British Association for the Advancement of Science.
Prof. Kapp's address to Section "G." 1913. (In Electrician, Sept. 12. Serial, 1st part.)
Abstract of paper on the advantages of the various systems of electric traction.

Buchli, J.
1-C-1 Lokomotiven Gruppe 032 der Italienischen Staatsbahnen. 1913. (In Elektrische Kraftbetrieb und Bahnen, April 24.)
Details of the mechanical and electrical construction and equipment.

Calisch, L.
Economic aspects of electric traction and its advantages over steam. 1913. (In Electrician, Dec. 26.)
Deals with the economic advantages and financial results obtained in suburban railways by the use of electric traction.

Carlier, J.
La question de la traction electrique en Belgique. 1913. (In Societe Belge des Electriciens, Oct.)
On the electrification of railroads in Belgium; reviews the complete steam equipment, outlines the obvious advantages of electric traction and summarizes the one against the other.

Cauwenberghe, van.
Alternate-current locomotive of 1500 h. p. 1913. (In Electrician, Jan. 31.)
Translated abstract from Elek. Zeit.

de Marchena, E.
Comparison entre les systemes de traction en concurrence pour l'electrification des grandes lignes. 1913. (In Genie Civil, May 17.)

Comparison between traction systems in relation to main line electrification; the relative advantages of monophase and triphase systems.

de Muralt, C. L.

Electrification of heavy grades. 1913. (In Railway Age Gazette, Jan. 17.)

Investigates how electrification compares with grade reduction on the introduction of more powerful steam locomotives.

de Muralt, C. L.

Principles of electric railroading. 1913. (In Railway Age Gazette, Apr. 4. Serial, 1st part.)

Reviews some of the fundamental laws that underlie all propulsion of trains on tracks, showing how they affect the technical as well as the financial side of electrification.

Die elektrische Vollbahn Spiez-Brig. 1913. (In Elektrotechnik und Maschinenbau, Nov. 9. Serial, 1st part.)

The Spiez-Brig electric main line; the Lötschberg Railway, with special description of the new 2500 horse-power Oerlikon locomotives.

Direct current, 2400-volt low-motives for Butte, Anaconda & Pacific Railway. 1913. (In Electrical Review and Western Electrician, June 14.)

Illustrated description of locomotives of the articulated double truck type with all weight on drivers.

Discussion on "2400-volt railway electrification" (Hobart), and trunk line electrification (Kahler). 1913. (In Proc. American Institute of Electrical Engineers, Nov. Serial, 1st part.)

Electric locomotives for Mount Royal Tunnel. 1913. (In Canadian Engineer, Dec. 4.)

Illustrated description of the proposed locomotives which are the type known as box cab, articulated running gear.

Electric locomotives for Swiss Railway. 1913. (In Electrical World, Nov. 15.)

Illustrates and describes the single-phase 15,000 volts, 15 cycle 2500 h. p. units for use on the Loetschberg line operating through the Simplon Tunnel.

Electrical locomotives of the Lötschberg Railway. 1913. (In Electrical Review, Aug. 29.)

Illustrated detailed description of probably the most powerful locomotive yet built.

Electric locomotives for Mount Royal Tunnel. 1913. (In Canadian Engineer, Dec. 4.)

Illustrated description of the proposed locomotives which are the type known as box cab, articulated running gear.

Electric traction on the Mont Cenis line. 1913. (In Engineer, Dec. 19.)

Information from report of the chief engineer concerning this Italian railway and its operation.

Electrification of British railways. 1913. (In Electric Railway Journal, May 3.)

Survey of past and present electrification of steam railroads.

Electrification of the Butte, Anaconda & Pacific. 1913. (In Railway Master Mechanic, Aug.)

Describes one of the largest installations of electrical equipment for steam railroad service and the first in the United States to use d. c. locomotives on as high a potential as 2400 volts.

Electrification of the Midi Railway. 1913. (In Engineering, Jan. 31. Serial, 1st part.)

Illustrated description of the work of electrifying certain sections of this French line.

Electrification of the Swiss State Railways. 1913. (In Engineer, Dec. 26.)

Information concerning the Gotthard line, the choice of a current and related matters.

Electrification progress in the United States. 1913. (In Electric Railway Journal, May 31.)

Reviews the progress in steam railroad electrification from the earlier tunnel and terminal work to the long-distance and mountain railway projects.

Electrification work in Eastern Canada. 1913. (In Electric Traction, Dec.)

An account of a change to 600-volt d. c. operation on the Montreal & Southern Co.'s Ry.

Esbran, L.

Railway electrification problems in the United States. 1913. (In Engineering, June 27.)

Abridged translation of a contribution to the discussion of H. Parodi's paper presented to the Institution of Electrical Engineers.

Esleth, C. E.

Relative efficiencies of electric railroad distribution systems. 1913. (In General Electrical Review, Nov.)

Shows approximate all-day combined efficiencies from prime mover to train wheels for various methods of electrification.

French single-phase locomotive. 1913. (In Electric Railway Journal, Feb. 15.)

Illustrates and describes a 1500 h. p. locomotive being tried by the Midi Railway.

Giovene, Nestore.

Sistemi di trazione elettrica monofase, trifase ed a corrente continua ad alta tensione. 1913. (In Ingeg. Ferro., Nov. 30. Serial, 1st part.)

High tension monophase, triphase and continuous current electric traction systems; characteristics of the three systems, some plants and results of experiments.

Gratzmuller, M.

Sur la traction a courant continu a haute tension. 1913. (In Bulletin, Societe Int. d'Electriciens, Apr.)

High-voltage continuous current traction; a committee report on the availability of continuous current for heavy duty, and results on the lines now using it.

Guignard, M.

Projet d'electrification des lignes de petite banlien aboutissant aux gares de l'Etat a Paris. 1913. (In Genie Civil, Mar. 22.)

Electrification project for small suburban lines leading to the State terminals at Paris.

Haigh, B. Parker.

Electric locomotives for main line and suburban service. 1913. (In Mechanical Engineer, Aug. 29. Serial, 1st part.)

Deals with matters of design and construction.

Hellmund, R. E.

Electrification of trunk lines in Europe. 1913. (In Electric Journal, Oct.)

A resume of information gathered during a recent inspection trip of the more important European line electrifications.

Hellmund, R. E.

Neuere Personenzugs- und Güterzugslokomotiven der New York, New Haven & Hartford-Bahn und Boston and Maine-Bahn. 1913. (In Elektrische Kraftbetrieb und Bahnen, Sept. 14.)

New passenger and freight locomotives on the New York, New Haven & Hartford, and Boston & Maine Railways; detailed description of the several new types in the service of these roads.

Hobart, H. M.

Two thousand four hundred volt railway electrification. 1913. (In Proc. American Institute of Electrical Engineers, May.)

Discusses the altered conditions which often make electrical operation economically superior to steam operation.

Jacquin, Ch.

Les locomotives electriques a 15,000 volts du Chemin de Fer des Alpes Bernoises. 1913. (In Genie Civil, Nov. 1.)

Fifteen thousand volt electric locomotives for the Bernese Alps Ry.

Jullian, M.

The electrification schemes of the Chemin de Fer du Midi. 1913. (In Electrician, May 30.)

A summary of the reasons for electrifying certain sections and adopting single-phase traction with description of the plant equipment, etc.

Kahler, Charles P.

Trunk line electrification. 1913. (In Proceedings, American Institute of Electrical Engineers, May.)

Outlines steam railroad conditions in the West and gives some of the results which would occur with electric operation.

Kilchenmann, Bruno.

Betriebserfahrungen bei der elektrischen Zugförderung am Simplon. 1913. (In Elektrische Kraftbetrieb und Bahnen, July 24.)

Working practice with electric traction at Simplon; the power plants, wiring and locomotives in use to and through the tunnel.

Kleinow.

Der Kuppelrahmen und verwandte Getriebe als Antriebsmittel für elektrische Lokomotiven. 1913. (In Elektrische Kraftbetrieb und Bahnen, June 14.)

Coupling frames and connecting gear as driving mediums for electric locomotives; a study of different types.

Kahler, Charles P.

Steam railroad electrification. 1913. (In Journal, Associa-

tion of Engineering Societies, Sept.)

Outlines the apparatus and equipment needed to operate a railroad by electric power, showing the comparative cost of steam and electricity and some resulting improvements.

Kummer, W.

Ueber die Kraftwerksausnutzung beim zukunftigen elektrischen Betrieb der Schweizerischen Eisenbahnen. 1913. (In Schweizerische Bauzeitung, Feb. 15.)

Power requirements on future electrification of Swiss railways.

Kummer, W.

Utilization of power in the future electric operation of the Swiss railways. 1913. (In Bulletin International Railway Congress, July.)

Discusses the amount of power required, the conditions under which the power stations could be best utilized, and related topics.

Les nouvelles locomotives electriques de la ligne Milan-Varese. 1913. (In Genie Civil, Dec. 20.)

New electrical locomotives on line from Milan to Varese; description of mechanical and electrical features, for service on the Italian State Railways.

Lydall, F.

Electric locomotives. 1913. (In Journal, Institution of Electrical Engineers, Dec.)

Gives details of locomotives in service and in course of construction and discusses features of design.

Maintenance of Pennsylvania Railroad electric locomotives. 1913. (In Electric Railway Journal, Mar. 15.)

Illustrated description.

Maintenance on the electrified section of the Erie Railroad. 1913. (In Electric Railway Journal, June 7.)

Outlines the condition of an installation with single-phase current made six years previously near Rochester, N. Y.

Mazen, A. N.

Electrification of the State Railways; the Paris suburban lines. 1913. (In Electrician, May 30.)

An account of the traffic, working, choice of system, station, etc.

Montpellier, J. A.

Locomotive electrique systeme Thomson-Houston de la Compagnie des Chemins de Fer du Midi. (In Technique Moderne, April 15.)

Most powerful electric locomotives in the world, N. Y. C. & H. R. R. R. 1913. (In Railway Master Mechanic, May.)

Illustrated description of the 600-volt direct-current locomotives and related information.

Murray, W. S.

Heavy electrification tendencies. 1913. (In Electric Journal, Oct.)

Discusses the general aspects and reviews the tendencies of the present time.

New locomotives for the Lötschberg Railway. 1913. (In Engineer, Nov. 21. Serial, 1st part.)

Brief description of the line and of the new locomotives designed for a working capacity of 2500 h. p. when running at a speed of 50 kiloms. per hour for a period of 1½ hours.

New single-phase motor and phase convertor for locomotive service. 1913. (In Electric Railway Journal, Oct. 11.)

Illustrates and describes an experimental type of articulated locomotive with single phase commutator motors.

Notes on the Midi D. C. and A. C. electrifications. 1913. (In Electric Railway Journal, May 3.)

Describes an 850 D. C. third-rail local system and an experimental section operated at 16⅔ cycles, 12,000 volts and single-phase.

Nouvelle locomotive electrique de 1500 Chevaux de la Compagnie des Chemins de Fer de Midi. 1913. (In Technique Moderne, Jan. 1.)

A new 1500 h. p. electric locomotive for the Compagnie des Chemins de Fer du Midi; principal characteristics, and details of construction.

Parodi, M.

Note sur le developpement de la traction electrique en Italie. 1913. (In Revue Generale des Chemins de Fer, Nov.)

Notes on the development of electric traction in Italy; describes the systems employed, power stations, substations, transmission lines and locomotives.

Parodi, M.

Railway electrification problems in the United States. 1913. (In Electrician, May 30.)

Considers the various aspects of the problem when the substitution of electricity for steam appears to be justified by considerations of safety and economy.

Poschenrieder, P.

Die Entwicklung der elektrischen Bahnen. 1913. (In Elektrotechnik und Maschinenbau (Special), Mar.)

Development of the electric railway; progress made since the first experiments made by Faraday in 1821.

Potter, W. B.

Systems of electrification. 1913. (In General Electric Review, Nov.)

Considers the systems of operation in use, favoring the direct current systems.

Powerful articulated electric locomotives. 1913. (In Railway Age Gazette, Nov. 7.)

Drawing and information concerning the 110-ton locomotives for the New York Central.

Progress in electrification. 1913. (In Proc., New York Railroad Club, Mar. 21.)

Addresses by different experts in this field on the ninth annual electrical night.

Quereau, C. H.

Individual paper on maintenance of electrical equipment. 1913. (In Railway and Locomotive Engineering, July.)

A discussion from the viewpoint of a steam motive-power man.

Rohrer, F. F.

Norfolk & Western electrification. 1913. (In Electric Journal, Oct.)

An account of the plan to operate a main line over mountain grades in Virginia and West Virginia, handling heavy coal trains on up grades.

Seefehlner, Egon and Franz Popp

Die 800 PS - Locomotiven der Mittenwaldbahn. 1913. (In Elektrische Kraftbetrieb und Bahnen, May 4.)

800 h. p. locomotives for the Mittenwald Railway; detailed description covering construction and electrical equipment.

Single-phase locomotives for the Rhaltian Railway. 1913. (In Engineer, Oct. 3.)

Illustrates and describes the electric locomotives for this single-phase line in Switzerland.

Smith, Stanley Parker.

Use of single-phase commutator motors for electric traction on long distance railways. 1913. (In Minutes Proc., Institution of Civil Engineers.)

Discussion of technical problems involved in electrification of mail line railways.

Steinmetz.

Why steam railroads are electrifying. 1913. (In Electric Journal, Oct.)

Brief notes on the application of the electric system at terminals in tunnels, and on grades; locomotive development and use on main lines.

Storer, N. W.

Electrification of steam railways. 1913. (In Journal, Cleveland Engineering Society, Mar.)

Discusses questions regarding the applications, the advantages, costs, the successful installations at terminals, tunnels, etc.

Storer, N. W.

Trunk line electrification. 1913. (In Canadian Electrical News, Jan. 15.)

Briefly considers six types of high speed locomotives and other considerations in the choice of a system.

Tajani, Filippo.

I recenti progreso della trazione elettrica. 1913. (In Monitore Technico, Nov. 30.)

A review of new projects affected by improved methods during the preceding year.

Twenty-five hundred H. P. Lötschberg locomotives. 1913. (In Electric Railway Journal, Nov. 15.)

Illustrates and describes electric locomotives for single-phase operation at 15,000 volts on an Alpine trunk railroad, notable for a new form of drive with helical gearing and side rods.

Twenty-four hundred-volt direct-current locomotive; Butte, Anaconda & Pacific Railway. 1913. (In Engineering News, June 26.)

Utyborck, E.
Electrification of the Melbourne suburban railways. 1913. (In Bulletin, International Railway Congress, Nov.)
Information based on a report concerning the operation of these railways by direct current.
Wade, R. E.
Electrification of the Butte, Anaconda & Pacific Railway. 1913. (In Bulletin, American Institute of Mining Engineers, Nov.)
Describes a line using direct current at a potential of 2400 volts, the equipment and the performance.
Wichert, A.
Die Triebwagenausrüstungen der Chemins de Fer departmentaux de la Haute-Vienne. 1913. (In Elektrische Kraftbetrieb und Bahnen, Aug. 14.)
Motive equipment of the Departmental Railways of Haute-Vienne; territory covered, power production and distribution, and details of locomotive equipment.
Wood, B. F.
Operation of the electrified portion of the West Jersey and Seashore Railroad. 1913. (In General Electric Review, Nov.)
Gives complete operating statistics for the year 1912.
Zalleid, Hans.
Einige Gesichtspunkte zur Beurteilung der elektrischen Vollbahn-Traktion. 1913. (In Elektrisität und Maschinenbau, Aug. 31.)
On main line electrification study of the choice of systems best suited for particular services.

Year 1912

Articulated truck electric locomotives, N. Y., N. H. & H. R. R., 1912. (In Railway Master Mechanic, Nov., 1912.)
Illustrated description of engines under construction which combine the best features for heavy locomotives as shown by road service.
Bidault des Chaumes, A.
Essais de traction a courant monophase, à 12,000 colts, de la Compagnie des chemins de fer du Midi. 1912. (In Genie Civil, Dec. 28.)
Experimental traction, with monophase current at 12,000 volts, by the Compagnie des Chemins de fer du Midi; initial tests tending toward the electrification of a portion of the Midi System.
Biedermann.
Electrification of the railways. 1912. (In Bul., International Railway Congress, Sept.)
Critical review of a memoir by Oscar Kresse, setting forth the disadvantages of the electrification of The German State Railways.
Brecht, G.
Einiges über Elektrisierung von Hauptbahnen. 1912. In Elektrische Kraftbetrieb und Bahnen, Nov. 14, 1912.)
Electrification of main lines; outlines points to be considered in undertaking extensive electrification; choice of systems, locomotives, etc.
Brecht, G.
Electrification of main lines. 1912. (In Electrician, Nov. 29. Serial, 1st part.)
Gives reasons for the slow advance and detailed discussion of the systems for main line service; translation of an article in Elektrische Kraftbetrieb und Bahnen.
Civalleri.
L'elettrificazione della linea Dessau-Bitterfeld. 1912. (In Industria, Jan. 28. Serial, 1st part.)
Describes the route traversed and equipment of the line.
Clark, William J.
Electrification of main line railroads. 1912. (In Journal of the Franklin Institute, June.)
A general statement of the things electric traction has accomplished; and their bearing upon the electrification of main lines.
de Muralt, C. L.
Aspects of steam railway electrification. 1912. (In Railway Age Gazette, Oct. 4.)
Reviews what has been accomplished in trunk line electrification and the future outlook. The advantage of electric locomotives in ability to haul heavy trains over grades at same speed as on a level.
Discussion on "Induction machines for heavy single-phase motor service;" Electrical operation of the West Jersey Seashore Railroad;" "Analysis of electrification" on papers read by E. F. W. Alexanderson, B. F. Wood and W. S. Murray. 1912. (In Proceedings American Institute of Electrical Engineers, Jan.)
Electrical equipment of the Austrian State Railways. 1912. (In Electrical World, June 8.)
Illustrates and describes the generating, distribution, and rolling stock equipment for single-phase operation at 25 cycles.
Electrification; discussion on this subject as applied to railroads. 1912. (In Proceedings, New York Railroad Club, March 15.)
Electrification of the Butte, Anaconda & Pacific Railway, 2400 volts direct current. 1912. (In Railway and Engineering Review, July 6.)
Describes work in progress in Montana and the systems and equipment.
Electrification of the Lauban-Königszelt line. 1912. (In Railway Gazette, Feb. 9.)
Particulars concerning the projected electrification of this line and its branches in the mountainous districts of Prussia.
Electrification of the London and North-western suburban lines. 1912. (In Engineer, Dec. 20.)
Information regarding this proposed electrification.
Electrification of the Melbourne railways. 1912. (In Railway Gazette, Nov. 22.)
Abstract of recent report on the direct-current and single-phase systems.
Hewett, John R.
Notes on the operation of the Washington, Baltimore & Annapolis Railroad as a 1200-volt system. 1912. (In General Electric Review, July.)
On the economies effected and the satisfactory behavior and endurance of the apparatus, according to the amount of the service rendered the road.
Heyden.
Electric traction on the Dessau-Bitterfeld Railway. 1912. (In Bulletin, International Railway Congress, Oct.)
Detailed description.
Insull, Samuel.
Relation of central station generation to railway electrification. 1912. (In Proceedings, American Institute of Electrical Engineers, July, Dec.)
Diagrams, discussion and results comparing unified power supply with the group system for railway purposes.
Kleinow, W.
Wechselstromlokomotiven der Siemens-Schukertwerke für Vollbahnen. 1912. (In Elektrische Kraftbetrieb und Bahnen, Aug. 4.)
Siemens-Schukert A. C. locomotives for trunk lines; describes recent types of electric locomotives and their application.
Kliment, Leopold.
Future of locomotive construction. 1912. (In Bulletin International Railway Congress, Oct.)
Shows that the steam locomotive has not reached the limit of its development and that it will not be supplanted by the electric locomotive.
Kummer, W.
Der Kraftbedarf der Gotthardbahn mit Rücksicht auf die Neuanlagen für deren elektrischen Betrieb. 1912. (In Schweizerische Bauzeitung, March 9.)
Power reuirements of the Gotthard Railway in view of a new plant for its electrification; studies on the determination of such power requirements; diagrams.
Kummer, W.
Gotthardbahn und Giovi-Linie. 1912. (In Schweizerische Bauzeitung, Aug. 31.)
Gotthard Railway and the Giovi system; calculations of the power requirements in the electrification of this railroad.
London, Brighton and South Coast Railway electrification. 1912. (In Engineering, Jan. 26. Serial, 1st part.)
Introductory to a series of articles describing in detail this single-phase system.
Macauley, R. U.
Locomotives, steam versus electricity. 1912. (In Applied Science, Aug.)
Discusses the economic aspect of electrification of trunk lines, and the more important advantages claimed.
Marguerre.
Elektrisierung der Rjukanbahn. 1912. (In Elektrische Kraftbetrieb und Bahnen, Dec. 4.)
Electrification of the Rjukan Railway; an account of the work

completed on this Norwegian road; description of the line, and cars and locomotives used.

Nordmann, H.

Neuere Amerikanische Wechselstrom-Vollbahnen. 1912. (In Elektrische Kraftbetrieb und Bahnen, March 24. Serial, 1st part.)

The first part discusses the introduction of electric drive on the Boston and Maine Ry. through the Hoosac Tunnel.

O'Brien, E.

Electrification of railways. 1912. (In Mechanical Engineer, Dec. 29. Serial, 1st part.)

Discusses conditions required for successful operation, advantages of electric over steam traction, operation, etc.

Reichel, W.

Rundschau über die Elektrifizierung von Vollbahnen. 1912. (In Elektrische Kraftbetrieb und Bahnen, Jan. 14.)

Review of the electrification of main lines; discusses the electrification of some of the German railways.

Southern Pacific electric locomotives. 1912. (In Machinery (Ry. Ed.), Nov.)

Illustrated description of one of the new six-ton electric freight locomotives.

Southern Pacific electric locomotives. 1912. (In Railway Age Gazette, Nov. 22.)

Illustrated description of a 50-ton electric locomotive for freight and switching service.

Steam railroad electrification. 1912. (In Railway and Locomotive Engineering, Oct.)

Explains the operating and economical advantages of the electric locomotive.

Storer, N. W.

Problems of electric locomotive design. 1912. (In American Engineer, Nov.)

A discussion and brief description of the types now in service.

Storer, N. W.

Railway trunk line electrification. 1912. (In Railway Age Gazette, Nov. 1.)

Abstract of paper read before the Association of Railway Electrical Engineers; considers important problems and gives a resume and brief description of types of electric locomotives.

Study of the electrification of railway terminals in Chicago. 1912. (In Electric Railway Journal, Oct. 5.)

Valbreuze, M. de.

Quelques recentes locomotives a vapeur et electriques. 1912. (In Bulletin, Societe Int. d'Electriciens, March.)

Recent types of steam and electric locomotives; modern European and American types.

Van Kands, K.

Gotthardbahn und Giovi-Linie. 1912. (In Schweizerische Bauzeitung, Aug. 17. Serial, 1st part.)

The Gotthard Railway and Giovi system; reviews calculations and measurements for the electrification of the road.

Whitehead, J. B., and Arthur Curran.

Is electric traction coming for main-line railways? 1912. (In Cassier's Magazine, March.)

The operation of steam railroads by electric motors; the advantages of steam over electricity on railroads.

Wyssling, W.

Auszug aus der Mitteilung No. 4 der Schweizerischen Studienkommission für elektrischen Bahnbetrieb. 1912. (In Schweizerische Bauzeitung, Nov. 2.)

Extracts from Bulletin No. 4 of the Swiss Electric Railway Research Commission; discusses the questions of system and costs for hydro-electric power on Swiss railways.

Year 1911

Brighton and South Coast electrification. 1911. (In Electrical Engineer (Long.) May 12.)

Illustrated description of the extension to the Crystal Palace.

Bullara, S.

La tramvia a vapore extra e la sua elettrificazione. 1911. (In Ing. Ferro, May 1.)

The electrification of suburban steam railways.

Clise, Charles F.

Different types of railroad electrification. 1911. (In Yale Scientific Monthly, Nov.)

Brief description of the direct current, three-phase, and single-phase systems.

Dawson, Philip.

Electrification of a portion of the suburban system of the London, Brighton and South Coast Railway. 1911. (In Minutes Proc., Institution of Civil Engineers, March 14.)

Dawson, Philip.

Future of railway electrification. 1911. (In Engineer, Dec. 15.)

Considers the adoption of electricity in America on main lines and the progress in Europe.

Electrical equipment of the Detroit River Tunnel. 1911. (In Electric Railway Journal, Jan. 14. Serial, 1st part.)

Remarks on improvement of railroad facilities at Detroit, Michigan, with illustrated description of the electrical scheme.

Electrification of the Brighton Railway. 1911. (In Tramway and Railway World, May 4.)

Maps and illustrated description of the extension of the electrified lines to the Crystal Palace.

Electrification of the Hoosac Tunnel. 1911. (In Electric Railway Journal, July 1.)

Illustrated description of the Catenary construction, repair shops and operating features of this single-phase alternating-current system.

Electrification of the Kiruna-Riksgransen line of the Swedish Railways. 1911. (In Electric Raiyway Journal, May 6.)

Illustrates proposed electric locomotives, and gives information in regard to this polar zone railway.

Electrification of the Salt Lake and Ogden Railroad. 1911. (In Electrical Railway Journal, April 22.)

Electrification of the steam railroads in the Boston Metropolitan District. 1911. (In Journal Association of Engineering Societies, May 1911.)

Includes map and illustrations.

Hardcastle, H. K.

Hoosac tunnel electrification. 1911. (In Electric Journal, Oct.)

Illustrated detailed description of the electrification and method of operation of this tunnel on the B. & M. R. R.

Janin, E.

Les travaux d'amelioration de la Gare Saint Lazare et de ses Accès. 1911. (In Technique Moderne, May.)

Improvements to the Saint-Lazare station and its approaches, Paris; briefly describes a project for electrifying the State Railway suburban lines west of Paris.

La trazione elettrica monofase sulla linea Dessau-Bitterfeld. 1911. (In Ingegneria Ferrovia, Dec. 16.)

Monophase electric traction on the Dessau-Bitterfeld line; details of overhead construction, generating stations, locomotives, etc., on this German road.

McCrea, J. A., G. F. Swain, H. Gilliam and William McClellan.

Electrification. 1911. (In Proc., New York Railroad Club, Mar. 17.)

Short papers, with general discussion in which many expert electrical engineers took part.

Monchamps, J.

L'electrification des chemins de fer. 1911. (In Alliance Industrielle, Nov.)

Description of monophase and triphase currents and electric installations.

Montpellier, J. A.

L'electrification du réseau Pyreneen de la Compagnie des chemins de Fer du Midi. 1911. (In Technique Moderne, Jan.)

Electrification of the Pyrenees sections of the Midi Railway; a brief description of the project.

Murray, William S.

Electrification analyzed and its practical application to trunk line roads, inclusive of freight and passenger operation. 1911. (In Proceedings, American Institute of Electrical Engineers, April.)

Report of the "Joint Board on Metropolitan Improvements" on electrification of the steam railway lines entering Boston. 1911. (In Engineering News, Feb. 2.)

Rogers, Warren O.

Electrification of the Hoosac Tunnel. 1911. (In Power, July 4.)

Illustrated description of the line construction, electric locomotives and plant for supplying the energy.

Seley, C. A.

Electrification of the Chicago Railways. 1911. (In Proceedings, Western Railway Club, Mar. 21.)

Bases conclusions, mainly on the work of the Boston Commission; general discussion follows:

Usbeck, Werner.
Overhead construction on the Dessau-Bitterfeld Railway. 1911. (In Electrician, Dec. 29.)
Describes the overhead catenary system used on a portion of the Prussian State Railways.
Valbreuze, M.
L'electrification des chemins de fer. 1911. (In Bulletin Societe d'Encouragement de l'Industrie National, Mar.)
Electrification of railways; review of the present status of heavy trunk line electric traction throughout the world.
Williams, A. D.
Electrification problem on trunk line railways. 1911. (In Engineering Magazine, Feb.)
Considers the problems that must be solved before any general revolution in methods of operation can occur.

Year 1910

Boston electrification problem. 1910. (In Electric Railway Journay, Nov. 19.)
Abstract of reports of the N. Y., N. H. & H. R. R., and of the B. & A. R. R., relating to the electrification of all steam railroads within the Boston district.
Carter, W. F.
Electrification of suburban railways. 1910. (In Proc., Institution of Mechanical Engineers, July.)
Discusses the advantages of electrification of existing steam operated lines for suburban service in England.
Darlington, Fred.
Electric power for railroad operation. 1910. (In Proc., Richmond R. R. Club, Mar 14.)
Mainly a discussion of the commercial aspects.
Same: 1910. (In Electrical Journal, Sept.)
Darlington, F.
Financial aspect of the application of electric motive power to railroads. 1910. (In Engineering Magazine, Feb.)
Discusses the relative economy in both local and long-distance traction.
Darlington, F.
Present status and tendencies of railroad electrification in America. 1910. (In Proc., Central Railway Club, May 13.)
Gives a short review of old electric railroad systems; comparing their first cost and efficiency.
Electrification of steam railways (Editorial). 1910. (In Engineering News, Sept. 22.)
Electrification of the Lapland Railway (Editorial). 1910. (In Engineering, March 11.)
On the impending electrification of an important Swedish State Railway through Lapland.
Electrification of the Lapland Railway. 1910. (In Engineering, July 1.)
Gives details of the plans with a map of the district affected.
Gibbs, George.
Electric traction. 1910. (In Railway Age Gazette, Mar. 25.)
Discusses electric locomotives, the first cost of electrification, cost of operation, with general remarks.
Same: Cost of electric operation of steam railways. 1910. (In Engineering News, Mar. 31.)
Hobart, H. M.
Cost of electrically-propelled suburban trains. 1910. (In Proc., Institution of Mechanical Engineers, July).
Comparison of systems showing that the continuous system has decided commercial advantages over the single-phase system for this service.
Hobart, H. M.
Electric railway cost estimating. 1910. (In Electrical Engineer, Nov. 25.)
Discusses the electrification of suburban service on steam railroads describing the estimation of costs for a hypothetical case.
Hraschka, Arthur.
Bericht über die Vorarbeiten zur Elektrifizierung der K. K. Oesterreichischen Staatsbahnen. 1910. (In Elektrische Kraftbetrieb und Bahnen, Sept. 4.)
Project for the electrification of the Austrian State Railways; report of preliminary studies.
Jacquin, J.
Electrification of the Bavarian State Railways. 1910. (In Bull., International Railway Congress, Jan.)
Review of a recent report.
Katte, Edwin B.
Electrification of the New York Central Railroad. 1910. (In Sibley Journal of Engineering, Nov.)
An illustrated description of the apparatus in the Port Morris Power Station and other features of the work.
Keely, R. R.
Electrification of steam roads. 1910. (In Canadian Engineer, Sept. 15.)
Summarizes the advantages and disadvantages of electrification, discussing the relative merits of the various systems, and gives tabulated tests of important electric railroads.
Mills, James Cooke.
Electrification of the Detroit Tunnel. 1910. (In Cassier's Magazine, Dec.)
Illustrated description of installation of electric traction machinery.
New York Railway Club.
Report of committee on electrification. 1910. (In Proc., New York Railroad Club, Mar. 18.)
Report and general discussion with illustrations.
Oefverholm, J.
Einführung des elektrischen Betriebes auf der Schwedischen Staatsbahnstrecke Kiruna-Riksgränsen. 1910. (In Elektrische Kraftbetrieb und Bahnen, Sept. 4.)
Brief description of the line and equipment.
Pomeroy, L. K.
Electrification of trunk lines. 1910. (In American Engineer and Railroad Journal, Feb.)
Discussion of the problem of electrification.
Same: 1910. (In Railway Age Gazette, Feb. 18.)
Pomeroy, L. R.
Electrification of trunk lines. 1910. (In Journal, American Society of Mechanical Engineers, Feb.)
Discusses the commercial considerations relating to this question.
Potter, William Bancroft.
Economics of railway electrification. 1910. (Journal American Society of Mechanical Engineers, July.)
Discusses conditions, determining railway equipment.
Substitution of electric traction for steam in the Boston Metropolitan District. 1910. (In Engineering News, Dec. 8.)
Gives the abstracts of reports made by the N. Y., N. H. & H. R. R. and the B. & A. R. R.
Westinghouse, George.
Electrification of railways. 1910. (In Journal, American Society of Mechanical Engineers, July.)
Calls attention to the necessity for the early selection of a system for universal use.

Year 1909

Approaching transfer of the electrification problem. 1909. (In Proceedings, New York Railroad Club, Mar. 19.)
Aspinwall, John A.
Presidential address before the Institution of Mechanical Engineers. 1909. (In Proceedings, Institution of Mechanical Engineers, Apr. 23.)
A general discussion of the electrification of steam railways.
Carter, F. W.
Electrification of railways; a general comparison of systems. 1909. (In Electrical Engineer (London), Feb. 26.)
Compares in a general way the merits and demerits of the various systems of operation; paper read before the Rugby Engineering Society.
Darlington, F.
Substitution of electric power for steam on American railroads. 1909. (In Engng. Mag., Sept.)
A discussion with reference to American practice, concluding that self-preservation demands its progressive adoption.
Dawson, Philip.
Railway electrification. 1909. (In Electrical Review (Lond.), Feb. 5. Serial, 1st part.)
Briefly considers a few advantages in the case of long distance lines.
Delmar, William A.
Difficulties of underground transmission for trunk line electrification. 1909. (In Electrical Age, June.)
An examination of the construction and operation difficulties in underground transmission.
de Muralt, C. L.
Choice of a system of electrification for trunk lines. 1909. (In Proc., American Institute of Electrical Engineers, Sept.)

Discusses only lines now operated by steam, investigating the merits of the four electric systems and comparing them.

de Muralt, C. L.

Some notes on railroad electrification. 1909. (In Michigan Technic, Feb.)

An explanation of the differences in continuous current, single-phase and three-phase systems.

Electrification of the South London line of the London, Brighton & South Coast Railway. 1909. (In Railroad Age Gazette, Aug. 6.)

Brief illustrated account of work in progress in England and the equipment adopted.

Electrification of the State Railways of Italy. 1909. (In Engineer, April 16.)

Extracts from information supplied by the general director of the State Railways of Italy.

Evans, H. H.

Developments in electrification of railway terminals. 1909. (In Journal, Western Soc. of Civil Engineers, April.)

Discussion of the advantages, the economies gained and the factors that lead to electrification.

Frischmuth, E.

Introduction of electric traction on main-line railways. 1909. (In Bull., International Railway Congress, Aug.)

Report of a paper read before the Elektrotechnische Verein; discusses the advantages, working, maintenance, system, etc.

Gerli, Emilio.

Gli sutdie per la trazione elettrica in Svizzera. 1909. (In Ing. Ferro, June 1. Serial, 1st part.)

A resume of the results of recent extended investigations.

Lagerwey, J. K.

Inlaiding tot de Studie van het hydroelectrische Vraagstuk betreffende de Spoorwegen op Java. 1909. (In Ingenieur, Oct. 2.)

Study of the possibility of supplying electric power for the railways of Java.

Lake, Edward N.

Some phases of steam-railroad electrification in the United States. 1909. (In Engineering Magazine, July.)

A study of progress and discussion of the outlook.

New York Central Railway electrification. 1909. (In Tramway and Railway World, Jan. 7.)

Brief illustrated description of a conversion of a part of this steam railroad to electric traction on the continuous current system.

O'Brien, H. E.

Electric traction on urban and interurban steam railways. 1909. (In Electrician, Jan. 22.)

Discusses the value of electrification, summing up against electric traction on main lines; abstract from Proceedings of Liverpool Engineering Society.

Proposal to force the railways entering Chicago to adopt electricity. 1909. (In Engineering News, Oct. 7.)

Proposed electrification of part of the Grand Trunk Pacific (Editorial). 1909. (In Railway Age Gazette, April 30.)

On the proposal to electrify the portion of the line between the St. Lawrence River and Moncton, New Brunswick.

Shaw, Dalziel and Sayers, and Harrison.

Electric traction on the Mersey, the Midland and the North Eastern Railway. 1909. (In Minutes Proceedings, Institution of Civil Engineers, Nov. 9.)

Seley, C. A.

Electrification of the Chicago Railways. 1909. (In Proc., Western Railway Club, Nov. 16.)

A detailed discussion of the subject showing that at the present time the demand for electrification is unreasonable.

Storer, N. W.

Railway electrification. 1909. (In Sibley Journal of Engineering, June.)

Uytborck, E.

Electrification of the Heysham, Morecombe and Lancaster branch of the Midland Railway. 1909. (In Bulletin, International Railway Congress, April.)

Describes the various installations, calling attention to the special peculiarities.

Year 1908

Katte, Edwin B.

Electric traction on steam railroads. 1908. (In Sibley Journal of Engng., Dec., 1908.)

Remarks on the advantages of electric operation, the systems commonly used, and the electrification recently installed on the N. Y. C. & H. R. R. R.

Murray, W. S.

Log of the New Haven electrification. 1908. (In Proc., Amer. Institute of Electrical Engineers, Dec., 1908, May, 1909.)

Aims to bring the actual operation of the New Haven single-phase electrification as closely as possible to those interested.

Proposed change to electric traction at the Chicago Terminal of the Illinois Central R. R. 1908. (In Engineering News, Dec. 24.)

From report by a special committee in connection with smoke abatement; outlines the present situation and discusses questions relating to the electrification.

Uytborck, E.

Notes taken during a journey of inqiury in the United States. 1908. (In Bull., International Railway Congress, Nov.)

Principally an illustrated description of the electrification of the N. Y. C. & H. R. R. and the N. Y., N. H. & H. lines and their equipment, with criticism and comparison.

Wyssling, W.

Mitteilungen der Schweizerischen Studienkommission für elektrischen Bahnbetrieb. 1908. (In Schweizerische Bauzeitung, Oct. 17. Serial, 1st part.)

Report of the Swiss Commission on electrification.

Yerbury, H. E.

Inaugural address to the Leeds Local Section of the Institution of Electrical Engineers. 1908. (In Electrician, Nov. 6.)

Reviews the progress made in the electrification of tramways and railroads.

Your committee desire to acknowledge the valuable assistance rendered by F. H. Perry of the Pennsylvania Railroad in preparing this report.

Committee: E. Wanamaker (electrical engineer, C. R. I. & P.), chairman; C. H. Quinn (chief electrical engineer, N. & W.); J. A. Shaw (general electrical engineer, C. P.); J. H. Davis (electrical engineer, B. & O.); E. W. Jansen (electrical engineer, I. C.); H. E. Fox (mechanical engineer, C. M. & St. P.); C. P. Kahler (electrical engineer, O. S. L.); R. V. Sprague, F. H. Geibel (assistant electrical engineer, S. P.); E. Marshall (electrical engineer, G. N.).

Discussion

Owing to the fact that the report of the Committee on Electrification consists primarily of an outline of procedure to be followed in the investigation of any particular project, the report was not read. E. Wanamaker of the Rock Island Lines, in speaking of the report, said that the committee would like to have any of the members after going through the report send in any suggestions that they might have. He stated that the committee had been aided by many others in the preparation of the report, particularly Mr. Miller of the Pennsylvania Railroad. He explained that it was not the idea of the committee to place in the hands of those interested, information that they could use directly, but rather something that would be a help in case they wanted to do something later, perhaps in 10 or 15 years. This is an important feature and one which should be kept before the railroad management so that a lot of money is not spent on facilities that may later have to be discarded. Mr. Wanamaker said the report did not go into details but rather it outlined a form that would allow any railroad to investigate its particular electrification problem. He further stated that he felt that the committee should help in securing facilities and supplying equipment necessary to make these investigations and that it should not be left to outsiders who were not railroad men. The electrification of no two sections of road, he said, would probably be the same and in his opinion the subject was deep and intricate and the most people did not realize the great number of things involved.

Mr. Wanamaker believed that the men making investigations tending to electrification should possess 90 per cent railroad ability for every 10 per cent of electrical ability. When electrical men on the railroads become railroad-elec-

trical men then progress will be made. At the present he said electrical men were slow to branch out but there was no question but that they were coming into their own.

Mr. Gardner emphasized Mr. Wanamaker's thought with reference to the electrical men. He said that when the roads got to running by electricty then the electrical engineer would have a real job. On most roads at the present time, he added, the electrical department comes under the mechanical head. He also pointed out the great amount of work that the committee had done in the preparation of the report.

Mr. Quinn stated that the report dealt with details of both operating and accounting and expressed the desirability of getting as close to the big operating and accounting men as possible because they have information that may be wanted some day by the electrical engineer. This information is vitally necessary for it will put the electrical man in a position to analyze the problems and make it possible for him to talk upon the question from the view point of the big operating and accounting men. Mr. Quinn then gave a short description of the principal points in the electrification of the Norfolk & Western.

Report on Incandescent Lamps and Lamp Specifications

Need is Shown for the Development of a Rugged Type of Tungsten Lamp for Portable Service

As outlined at the Atlantic City meeting, development in incandescent lamps, at least for commercial purposes, was largely curtailed during the war. Your committee, therefore, has but relatively little to report this year. Consideration has been given to subjects as outlined in progress report submitted at the June meeting.

Lamps for Portable or Extension Light Service

During the war production of carbon lamps was materially curtailed, while the manufacture of Gem or metallic filament lamps was practically eliminated. This has proved a rather serious matter to railroads who use a relatively large number of carbon lamps in extension cord service where they are subjected mechanically to severe usage. These conditions resulted in the necessity of using tungsten lamps to a large extent in this class of service, which has been expensive and otherwise unsatisfactory. If carbon lamps are gradually to disappear it is essential that a cheap and rugged lamp be developed as a substitute. As a very large percentage of lamp failures in this service is due to mechanical breakage the development of a rugged filament construction will not solve the problem unless the price can be reduced to a figure approaching a high grade carbon lamp. There has been placed on the market a so-called mill type of tungsten lamp which has a filament mounting designed to withstand vibrations such as may occur in shop conditions where lamps are supported near machinery, shafting, etc.; but this lamp is not designed to meet the severe conditions of portable lighting service.

There is no immediate prospect of development of a low wattage 110-volt class tungsten lamp having filament construction rugged enough to withstand this service successfully and at the same time *have* low first cost. Two railroads are using 30-volt circuits to some extent for extension light purposes in their shops which permits the use of a much more rugged filament construction. Your committee feels, however, that as this practice is rather special, involving separate wiring, etc., it cannot be recommended at this time for general use. It is believed, therefore, that use of carbon lamps for this class of service should be continued. It is recognized that with the decreasing demands for carbon lamps and the fact that their use is being confined more and more to secondary service that the quality is gradually deteriorating as compared with the time when carbon lamps were used for general illumination purposes. There is sufficient demand, however, in the railroad field for carbon lamps to justify keeping up the quality which can be done if railroads will purchase lamps of this character under suitable specifications. As to the difficulty in obtaining carbon lamps in sufficient quantity, while this situation was rather acute during the war, it has now improved to considerable extent and at least one large railroad system, which has come to the attention of the committee, is having no difficulty in obtaining carbon lamps with reasonable deliveries.

New Developments in Incandescent Lamps for Commercial Purposes

On account of war conditions there have been relatively few developments of incandescent lamps for commercial purposes since the last committee's report on this subject. The lamps that have been brought out are as follows:

1st—100-watt, type C, tungsten lamp, PS-25 bulb in 220-250 class, is just being placed on the market. The efficiency of this lamp, however, as yet represents but little increase over the vaccum or type B lamp, being 9.31 lumens per watt as compared with 9.04 for the vacuum type.

2nd—Mill type tungsten lamps, 25 and 50 watt, 110-125-volt and 220-250-volt classes; also in 275-volt class, for mine lighting, are commercially available.

3rd—50-watt, PS-20, type C tungsten lamp in white glass tipless bulb for 110-125-volt service, has recently been placed on the market.

4th—For stereopticon service developments have been as follows:

6 and 12 volt	72 and 108 watts	T-10 bulb
28-30 volt	300 watts	T-16 bulb
110-125 volt	300 watts	T-16 bulb
110-125 volt	600 watts	T-20 bulb

5th—For motion picture projection service developments cover:

28-30 volt	600 and 900 watts	T-20 bulb

While there is but little demand for the white glass in railroad service, there is a limited use for stereopticon and motion picture lamps. Many railroads are using equipment of this character in connection with educational and safety first work, and it will be found that the incandescent lamps are not only convenient but more satisfactory that arc light apparatus.

Train Lighting Lamps

Experience would indicate that there is no need for further changes in rating or in number of sizes of lamps for train lighting purposes from the schedule and method of rating as adopted by the Association a few years ago, except that it is desirable to reduce the number of sizes in use. Your committee endeavored to compile data showing the production of the various types and sizes of train lighting lamps, but it was found impossible to obtain reliable information due to the fact that lamps of this type are also used in country home lighting service. Based on 1918 records, sales of straight sided lamps exceeded the round bulb lamp. In view of the much lower cost, particularly in the larger sizes, of the former type their use is strongly recommended for train lighting service wherever possible. There appears to be but small demand for the 10 and 20 watt lamps, indicating that the 15, 25 and 50 watt sizes are those generally used for this class of service. As the cost of the 15 and 25 and 50 watt lamps is the same in the straight-sided bulb type, the use of the 50-watt size for general illumination in car lighting service is recommended wherever it is possible to reduce the number of lamp outlets by so doing. This practice will not only reduce initial cost for fixtures, reflectors and wiring, but will represent considerable saving in maintenance.

In the type C train lighting lamps of 40, 75 and 100 watt sizes the last two are being used to some extent. At the present time there is little justification for the use of 40-watt type C lamps in that they cost 100 per cent more than the type B straight-sided bulb lamp having the same lumen output and represent a reduction in actual wattage of about 7.3 per cent. With the tendency towards higher illumination values there should be an in-

creasing demand for the 75-watt lamp for general train lighting purposes.

Headlight Lamps

Use of lamps in headlight and cab light service has developed at an extremely rapid rate, but due to war and other conditions there has been but little opportunity to study their performance under service conditions. There is in general use 15-watt, S-17 bulb, 34-volt tungsten cab light lamp which has a different filament mounting than the train lighting lamp to withstand the more severe service; also the 100-watt and 250-watt round bulb headlight lamps. Headlight lamps smaller than the 100-watt size have been produced experimentally for switching locomotive service. Reports in general indicate there is considerable room for improvement in construction of lamps for this purpose, although very little definite data is available at the present time as to details of the trouble experienced. It would appear that cab lamps having somewhat lower efficiency could be used to secure longer life. To considerable extent these lamps burn practically continuously and in addition may be subjected to a voltage somewhat higher than normal when the headlight is turned out. Some trouble has also been reported with bases of the headlight lamps becoming loose due to cement melting. It appears that the temperature at the lamp socket, particularly with the 250-watt size lamp, is relatively high and that cement suitable to withstand these temperatures must be used. While headlight lamps of less than 100-watt size have been used to some extent in switching service it is questionable whether they will meet the I. C. C. illumination requirements, in which connection further tests would be desirable to determine the best size of lamp for this purpose.

As the lamp question for locomotive service is one of the most important items affecting headlight maintenance cost, it is recommended this subject be gone into thoroughly another year in conjunction with the headlight committee.

Incandescent Lamp Specifications

Developments in incandescent lamps during the past few years have been such that the present incandescent lamp specifications prepared by the Association are now obsolete. It has been found that these specifications have been but little used by the railroads and further, question has been raised as to the necessity or desirability of the railroads purchasing lamps under specifications materially different from those used by other large purchasers except that such specifications should include test limits, etc., for those classes of lamps used only in railroad service. It is felt, therefore, that before redrafting the text of the present specification that an opportunity should be given for consideration of the subject by representatives of a number of railroads. It was found impracticable to do this during the past year.

The Bureau of Standards, however, have issued the 8th edition of their incandescent lamp specifications under date of April 13, 1918, the revision having been made after a thorough consideration of the subject by all concerned. The so-called "standard" incandescent lamp specifications conform practically to these specifications.

At least until this subject can be given further consideration it is recommended for those railroads which do not already have their own incandescent lamp specifications that they make use of the Bureau of Standards specifications in the purchase of incandescent lamps. However, as these specifications cover only certain types of lamps, we are giving below the latest revision of lamp ratings, test limits, etc., for the various types and sizes of lamps in general use.

Carbon Multiple Lamps

This schedule applies to large, regular, clear, carbon lamps from 110 to 125 volts and from 220 to 250 volts, for multiple burning, and, with the General Specifications for incandescent electric lamps, forms complete specifications for lamps of such sizes as are specifically mentioned herein.

QUANTITY NECESSARY FOR REJECTION

When tested at the factory, any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

(Continued on page 359)

Tungsten B Lamps for 110-125-Volt Multiple Circuits

Revised January 1, 1919

This schedule applies to large, clear tungsten lamps of from 110 to 125 volts, for multiple burning, and with the General Specifications for Tungsten Incandescent Electric Lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

QUANTITY NECESSARY FOR REJECTION

When tested at the factory any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

INITIAL LIMITS, RATING AND LIFE PERFORMANCE

(*a*) *Values for clear 110- to 125-volt tungsten lamps for multiple burning.*

Size of Lamp in Watts	Bulb Designation	INITIAL RATED		INITIAL LIMITS AT RATED VOLTAGE		AVERAGE PERFORMANCE†	
		Lumens per Watt	Watts per Horizontal Candle*	Individual Watts per Horizontal Candle, Maximum and Minimum Per Cent	Individual Total Watts Maximum and Minimum Per Cent	Initial Rated Watts per Spherical Candle-Power	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Rated Watts per Spherical Candle
10	S-17	7.52	1.30	8	10	1.67	1000
15	S-17	8.32	1.18	6	8	1.51	1000
25	S-17	9.04	1.08	6	8	1.39	1000
40	S-19	9.24	1.06	6	8	1.36	1000
50	S-19	9.45	1.04	6	8	1.33	1000
60	S-21	9.59	1.02	6	8	1.31	1000

The average initial spherical reduction factor which applies to all lamps in the above table is 78 per cent.

*Upon notice from the Manufacturer, any or all of the initial rated watts per horizontal candle shown in above table may be numerically increased by not to exceed 5 per cent or decreased by not to exceed 10 per cent and the other efficiency ratings to be changed accordingly. Upon the establishment of new rated efficiencies the Manufacturer may issue a new schedule. The initial limits and test life period specified in the table shall apply to the lamps at the increased or decreased watts per candle.

†At the option of the Purchaser life tests may be made at special efficiencies mutually agreed upon by the Manufacturer and Purchaser.

(*b*) All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

(*c*) The labels on the lamps shall show the nominal total watts and voltage.

Tungsten C Lamps for 110-125-Volt Multiple Circuits

Revised January 1, 1919

This schedule applies to large, clear tungsten C lamps of from 110 to 125 volts, for tip down, multiple burning, and with the General Specifications for Tungsten Incandescent Electric Lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

QUANTITY NECESSARY FOR REJECTION

When tested at the factory any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

INITIAL LIMITS, RATING AND LIFE PERFORMANCE

(*a*) *Values for clear 110- to 125-volt tungsten C lamps for tip down, multiple burning.*

Size of Lamp in Watts	Bulb Designation	INITIAL RATED		INITIAL LIMITS AT RATED VOLTAGE		AVERAGE PERFORMANCE.†
		Lumens per Watt	Watts per Spherical Candle	Individual Watts per Spherical Candle, Maximum and Minimum Per Cent	Individual Total Watts Maximum and Minimum Per Cent	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Rated Watts per Spherical Candle
75	PS-22	11.53	1.09	15	18	1000
100	PS-25	12.57	1.00	12	18	1000
150	PS-25	13.66	0.92	12	15	1000
200	PS-30	15.14	0.83	12	15	1000
300	PS-35	16.11	0.78	12	15	1000
500	PS-40	17.45	0.72	12	12	1000
750	PS-52	18.48	0.68	12	12	1000
1000	PS-52	19.33	0.65	12	12	1000

*Upon notice from the manufacturer, any or all of the initial rated watts per spherical candle shown in above table may be numerically increased 5 per cent or decreased by not to exceed 10 per cent and the initial rated lumens per watt will be changed accordingly. Upon the establishment of new rated efficiencies the manufacturer may issue a new schedule. The initial limits and average performance specified in this table shall apply to the lamps at the increased or decreased watts per candle.

†Until further notice a leeway of 5 per cent in candlepower maintenance will be allowed the manufacturer on tungsten C lamps.

(*b*) All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

(*c*) The labels on the lamps shall show the nominal total watts and voltage.

Tungsten B Lamps for 220-250-Volt Multiple Circuits

Revised July 1, 1917

This schedule applies to large, clear tungsten lamps of from 220 to 250 volts for multiple burning, and with the General Specifications for Tungsten Incandescent Electric Lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

Quantity Necessary for Rejection

When tested at the factory any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

Initial Limits, Rating and Life Performance

(*a*) *Values for clear 220- to 250-volt tungsten lamps for multiple burning.*

Size of Lamp in Watts	Bulb Designation	INITIAL RATED		INITIAL LIMITS AT RATED VOLTAGE		AVERAGE PERFORMANCE†	
		Lumens per Watt	Watts per Horizontal Candle*	Individual Watts per Horizontal Candle, Maximum and Minimum Per Cent	Individual Total Watts Maximum and Minimum Per Cent	Initial Rated Watts per Spherical Candle-Power	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Rated Watts per Spherical Candle
25	S-19	7.62	1.30	9	12	1.65	1000
50	S-19	8.79	1.13	9	12	1.43	1000
100	S-30	9.45	1.05	9	12	1.33	1000

The average initial spherical reduction factor which applies to all lamps in the above table is 79 per cent.

*Upon notice from the manufacturer, any or all of the initial rated watts per horizontal candle shown in above table may be numerically increased by not to exceed 5 per cent or decreased by not to exceed 10 per cent and the other efficiency ratings to be changed accordingly. Upon the establishment of new rated efficiencies the manufacturer may issue a new schedule. The initial limits and test life period specified in this table shall apply to the lamps at the increased or decreased watts per candle.

†At the option of the purchaser life tests may be made at special efficiencies mutually agreed upon by the manufacturer and purchaser.

(*b*) All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

(*c*) The labels on the lamps shall show the nominal total watts and voltage.

Tungsten B Lamps for Use, Five in Series on 525-, 550-, 575-, 600-, 625- and 650-Volt Street Railway Circuits

Revised January 1, 1919

This schedule applies to large, clear tungsten lamps for street railway service to burn five in series on 525, 550, 575, 600, 625 and 650 volts, and, with the General Specifications for Tungsten Incandescent Electric Lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

Quantity Necessary for Rejection

When tested at the factory any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

Rating

All tungsten street railway lamps of a given size are designed to operate at the same current and are selected for one-fifth of the voltage for which they are labeled for use in series.

The nominal candle-power and nominal wattage of lamps of the different voltage groups are shown in the following table.

Nominal Horizontal Candle-Power and Nominal Watts for Tungsten Lamps for Street Railway Series Burning

LABELED VOLTAGE GROUPS	SIZE OF LAMP 23 WATTS		SIZE OF LAMP 36 WATTS	
	Nominal Horizontal C-p. for Group	Nominal Watts Group	Nominal Horizontal C-p. for Group	Nominal Watts for Group
5 in series on 525 volts	19.4	22.5	32.1	35.9
5 in series on 550 volts	20.3	23.5	33.6	37.6
5 in series on 575 volts	21.2	24.6	35.1	39.3
5 in series on 600 volts	22.1	25.7	36.6	41.0
5 in series on 625 volts	23.0	26.8	38.2	42.8
5 in series on 650 volts	24.0	27.8	39.7	44.5

TABLE 1

INITIAL LIMITS, RATING AND LIFE PERFORMANCE

(a) Values for clear tungsten lamps for street railway series burning of voltage groups given above.

Size of Lamp in Watts (Nominal)	Bulb Designation	Rated Amperes	INITIAL RATED		INITIAL LIMITS WHEN TESTED AT NOMINAL HORIZONTAL CANDLE-POWER OF VOLTAGE GROUP		AVERAGE PERFORMANCE†	
			Lumens per Watt	Watts per Horizontal Candle*	Individual Watts per Horizontal Candle Maximum Minimum Per Cent	Individual Amperes Maximum and Minimum Per Cent	Initial Test Watts per Spherical Candle	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Test Watts per Spherical Candle
23	S-17	0.214	8.43	1.16	6	2.5	1.41	1000
36	S-19	0.342	8.73	1.12	6	2.5	1.36	1000

If the Purchaser so elects, the following table of limits may be substituted for Table 1.

TABLE 1A

INITIAL LIMITS, RATING AND LIFE PERFORMANCE

Values for clear tungsten lamps for street railway series burning of voltage groups given above.

Size of Lamp in Watts (Nominal)	Bulb Designation	Rated Amperes	INITIAL RATED		INITIAL LIMITS WHEN TESTED AT RATED AMPERES		AVERAGE PERFORMANCE†	
			Lumens per Watt	Watts per Horizontal Candle*	Individual Volts Maximum and Minimum Per Cent	Individual Watts per Horizontal Candle Maximum and Minimum Per Cent	Initial Test Watts per Spherical Candle	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Test Watts per Spherical Candle
23	S-17	0.214	8.43	1.16	6	6	1.41	1000
36	S-19	0.342	8.73	1.12	6	6	1.36	1000

NOTE.—If the above limits are used, current should be held on an ammeter reading directly to 0.002 amp.

The average initial spherical reduction factor which applies to lamps in the above tables is 78 per cent.

*Upon notice from the manufacturer, any or all of the initial rated watts per horizontal candle shown in Table 1 may be numerically increased by not to exceed 5 per cent or decreased by not to exceed 10 per cent and the other efficiency ratings to be changed accordingly. Upon the establishment of new rated efficiencies the manufacturer may issue a new schedule. The initial limits and test life period specified in Table 1 shall apply to the lamps at the increased or decreased watts per candle.

†At the option of the purchaser life tests may be made at special efficiencies mutually agreed upon by the manufacturer and purchaser.

(b) All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

(c) The labels on the lamps shall show the nominal total watts and the voltage of the circuit upon which a stated number of lamps are to burn in series.

Tungsten B Lamps for 30-34- and 60-65-Volt Train Lighting Circuits

Revised January 1, 1919

This schedule applies to large, clear tungsten lamps of from 30 to 34 and 60 to 65 volts for train lighting, multiple service, and with the General Specifications for Tungsten Incandescent Electric Lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

QUANTITY NECESSARY FOR REJECTION

When tested at the factory any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

INITIAL LIMITS, RATING AND LIFE PERFORMANCE

(a) Values for clear 30 to 34 and 60 to 65 volt tungsten lamps for multiple burning.

Voltage Range	Labeled Watts (Nominal)	Total Lumens	Bulb Designation	INITIAL RATED		Total Watts (Actual)	INITIAL LIMITS AT RATED VOLTAGE		AVERAGE PERFORMANCE†	
				Lumens per Watt	Watts per Horizontal Candle*		Individual Watts per Horizontal Candle, Maximum and Minimum Per Cent	Individual Total Watts (Actual) Maximum and Minimum Per Cent	Initial Rated Watts per Spherical Candle-Power	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Rated Watts per Spherical Candle
30–34...	10	85	S-17	9.17	1.08	9.3	6	8	1.37	1000
	15	125	S-17	9.59	1.03	13.0			1.31	
	20	175	S-17	9.74	1.02	18.0			1.29	
	25	250	S-17	9.74	1.02	25.7			1.29	
	50	500	S-19	10.13	0.98	49.3			1.24	
60–65...	15	125	S-17	9.11	1.09	13.7	6	8	1.38	1000
	25	250	S-17	9.24	1.07	27.0			1.36	
	50	500	S-19	10.13	0.98	49.3			1.24	
30–34...	10	85	G-18½	8.73	1.17	9.7	6	8	1.44	1000
	15	125	G-18½	9.11	1.12	13.7			1.38	
	25	250	G-18½	9.24	1.10	27.0			1.36	
	50	500	G-30	10.30	1.00	48.5			1.22	
60–65...	15	125	G-18½	8.73	1.17	14.3	6	8	1.44	1000
	25	250	G-18½	8.85	1.15	28.2			1.42	
	50	500	G-30	10.30	1.00	48.5			1.22	

The average initial spherical reduction factor which applies to all lamps in the above table in S-17 and S-19 bulbs is 79 per cent, to lamps in the G-18½ bulb is 81 per cent and to lamps in the G-30 bulb is 82 per cent.

*Upon notice from the manufacturer, any or all of the initial rated watts per horizontal candle shown in above table may be numerically increased by not to exceed 5 per cent or decreased by not to exceed 10 per cent and the other efficiency ratings to be changed accordingly. Upon the establishment of new rated efficiencies the manufacturer may issue a new schedule. The initial limits and test life period specified in this table shall apply to the lamps at the increased or decreased watts per candle.

†At the option of the purchaser life tests may be made at special efficiencies mutually agreed upon by the manufacturer and purchaser.

(*b*) All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

(*c*) The labels on the lamps shall show the nominal total watts and voltage.

Tungsten C Lamps for Constant Current Street Lighting Circuits

Revised January 1, 1919

This schedule applies to large, clear tungsten C lamps of 6.6, 15 and 20 amperes for tip down, street series burning, and with the General Specifications for Tungsten Incandescent Electric Lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

Quantity Necessary for Rejection

When tested at the factory any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the lamps showing physical defects.

When tested elsewhere any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

Initial Limits, Rating and Life Performance

(*a*) *Values for clear 6.6, 15 and 20 ampere tungsten C lamps for tip down, street series burning.*

Size of Lamp Nominal Candle-Power	Actual Spherical Candle-Power	Total Lumens	Bulb Designation	INITIAL RATED WATTS PER SPHERICAL CANDLE* AT RATED AMPERES			INITIAL LIMITS AT RATED AMPERES		AVERAGE PERFORMANCE†
				Rated Amp. 6.6	Rated Amp. 15	Rated Amp. 20	Individual Spherical Candle-Power Maximum and Minimum Per Cent	Individual Total Watts Maximum and Minimum Per Cent	Test Life in Hours to 20 Per Cent Drop in Spherical Candle-Power at Initial Rated Watts per Spherical Candle
60	47.7	600	S-24½	1.03	.....	.....	15	13	1350
80	63.6	800	S-24½	0.95	.....	.....	14	12	1350
100	79.5	1000	S-24½	0.90	.....	.....	14	11	1350
250	199.0	2500	PS-35	0.78	.....	.....	14	10	1350
400	318.0	4000	PS-35	0.78	.....	.....	14	10	1350
400	318.0	4000	PS-35	.....	0.70	.....	16	12	1350
600	477.0	6000	PS-40	0.78	.....	.....	14	10	1350
600	477.0	6000	PS-40	.....	.....	0.67	16	12	1350
1000	795.0	10000	PS-40	.....	.....	0.65	16	12	1350

*Upon notice from the manufacturer, any or all of the initial rated watts per spherical candle shown in above table may be numerically increased 5 per cent or decreased by not to exceed 10 per cent. Upon the establishment of new rated efficiencies the manufacturer may issue a new schedule. The initial limits and average performance specified in this table shall apply to the lamps at the increased or decreased watts per spherical candle.

†Until further notice a leeway of 5 per cent in candlepower maintenance will be allowed the manufacturer on tungsten C lamps.

(*b*) Lamps in this schedule shall be operated on life test in a vertical position, tip downward.

All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

(*c*) The labels on the lamps shall show the nominal candle-power and amperes.

Value for Clear, Oval-Anchored, 110 to 125 Volt Regulator Carbon Lamps for Multiple Burning

Size of Lamp in Watts a	Initial Mean Horizontal Candle-Power at Rated Voltage	INITIAL LIMITS AT RATED VOLTAGE				Average Performance
		Individual Candle-Power Limits	Mean Candle-Power Limits	Individual Watt Limits	Mean Watt Limit	Test Life in Hours to 20 Per Cent Drop in Candle-Power at 3.70 Watts Per Spherical Candle
25	8.1	1 cp above and 1 cp below	0.6 cp above and 0.6 cp below	10 per cent above and 10 per cent below	5 per cent above and 5 per cent below	300
50	16.8	7.5 per cent above and 7.5 per cent below	2.5 per cent above and 2.5 per cent below	5.5 per cent above and 5.5 per cent below	2.5 per cent above and 2.5 per cent below	450

Values for Clear, Double Oval-Anchored, 220 to 250 Volt Regular Carbon Lamps for Multiple Burning

35	8.0	2 cp above and 2 cp below	1 cp above and 1 cp below	15 per cent above and 15 per cent below	7.5 per cent above and 7.5 per cent below	120
60	16.3	15 per cent above and 15 per cent below	7.5 per cent above and 7.5 per cent below	12 per cent above and 12 per cent below	6 per cent above and 6 per cent below	160

a Average spherical reduction factor, 82.5 per cent.

NOTE.—*Excepted voltages.*—It is recommended that every effort be made to avoid ordering lamps of actual rated voltages 110, 111, 121 to 125, inclusive, and 220.

(Continued from page 356)

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

Values for Excepted Voltages.—Lamps in this schedule, of rated voltages 110, 121 to 125, inclusive, and also 220, may have double the limits of variation in the initial limits at rated voltage specified for their respective sizes.

Initial Limits, Rating, and Performance

For lamps of rated voltages between 120 and 125, inclusive, the test-life values shall be 95 per cent of those given in this table.

Lamps in this schedule should burn on life test in one horizontal position at a voltage corresponding to an initial specific consumption of 3.70 watts per spherical candle without excessive drooping of the filament.

The labels on the lamps shall show the nominal total watts and voltage.

Committee on Illumination—J. E. Gardner (electrical engineer, C. B. & Q), chairman.

Sub-Committee "B" on Incandescent Lamps and Lamp Specifications—L. S. Billau (assistant electrical engineer, B. & O.), chairman; J. L. Minick (electrical foreman, Pennsylvania, Lines East).

Discussion

The report of committee "B" on incandescent lamps and specifications was read by Mr. Billau. He said that the committee had taken this question up two years ago but that the developments in this last year had introduced a lamp for counry home lighting that fell into the 30-volt class. He thought that this might result in some confusion between this type of lamp and that ordinarily used for train lighting.

C. W. Bender of the National Electric Lamp Association

of the General Electric Company stated that no such confusion would occur, but Mr. Hack later said that he had already received some of the country home lamps in place of car lighting lamps.

It was recommended that a 50-watt lamp be substituted in place of the 40-watt lamp now in common use. This was put in the form of a motion and the recommendation was adopted.

Illumination of Cars is Becoming an Exact Science

First Class Lighting Engineering Practice is Required in the Design and Location of Fixtures

The illumination of railway cars offers a field for intensive study and investigation, both in regard to the methods employed in producing the light energy and in the application of the light sources to obtain proper illumination. In 1914 the Committee on Illumination covered this field admirably, giving invaluable data on train lighting. In this report we are simply bringing to date those subjects that appear to be most important and present the latest practices and information available. Investigations and developments since the publication of the 1914 committee report have been held in abeyance to a large extent, due to the unusual conditions, superimposed upon all the railroads and all concerns that would ordinarily develop this branch of illumination for the railroads.

Following are the subjects that it is deemed deserve special attention:

(1) Illumination, efficiency and uniformity, under which will be given the comparison of the various types of installations, also:

- a. Quality of illumination produced.
- b. Artistic merit.
- c. Efficiency and uniformity of distribution.
- d. Effect of coloring of head lining.

(2) Determination of intensity of illumination required.

- a. Test methods.
- b. Test results.
- a. Installation.
- b. Maintenance cost.
- c. Breakage.

This report has been divided into the various subdivisions as listed above, as adequate and proper illumination of passenger,

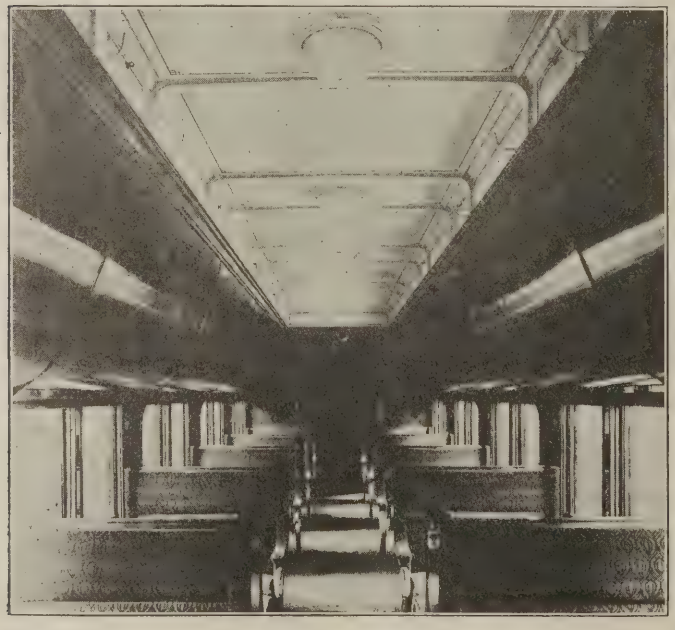


Fig. 1. Installation of L-182 Units Applied Directly Against Ceiling

postal and Pullman cars of the various types presents difficulties not met with in other lines of illumination engineering.

Illumination

For passenger work it is practically impossible to have the lighting fixtures out of the range of vision. Adequate screening of the light source is necessary. In addition to this, the constant motion of the car makes it necessary to have a greater amount of illumination than is required in places where this condition does not exist. There has been, in the past, a tendency to sacrifice proper illuminating results in favor of the appearance of the lighting fixtures rather than for proper illumination, but these mistakes are rapidly being corrected and we believe that the practice of proper illumination has advanced as far in car lighting as in any other field.

As the question of artistic merit was so definitely presented for discussion, this subdivision will be given considerable thought.

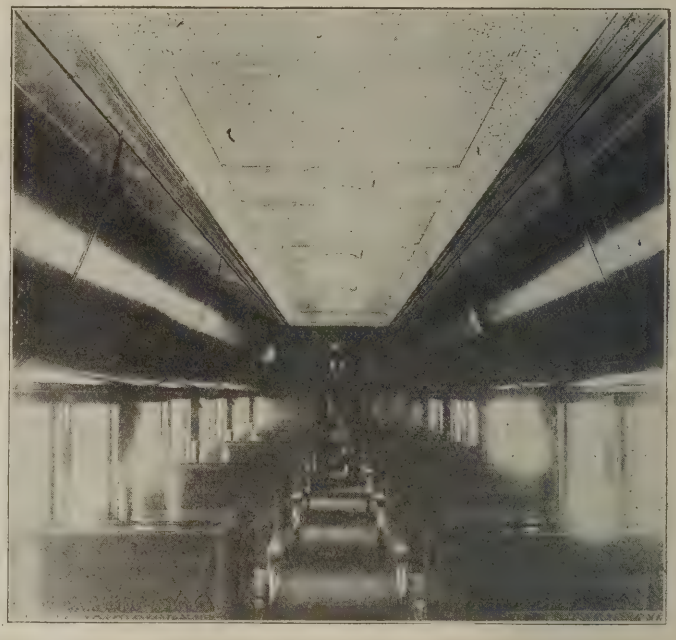


Fig. 2. Installation of L-182 Units with Square Mounting

It is an undisputed fact that practically all of the older type fixtures and lighting units were ornate, even to the extreme in many cases, with a resulting loss in light efficiency. At the present time the comment is made whether the fixtures and fans are not too plain, but we believe there is no ground for these comments, as it seems to be the consensus of opinion that the lighting arrangement and fixtures are a combination of efficiency in the illuminant and artistic effect as relates to the interior of a car.

In Figs. 1, 2 and 16 are shown L-182 units, as applied directly against the ceiling in Pullman cars and also when square mounting is placed between ceiling and fixtures. It has been found in practice that with this combination of a separate mounting base and the fixture, it is extremely difficult to obtain a perfect fit against a steel or "Agasote" ceiling, owing to the flexibility of these materials. If this base should be incorporated in the fixture itself it would greatly increase the cost, besides giving a bulky fixture. In general, it is believed that the L-182 unit, as used at present, meets all reasonable demands for an artistic fixture. This light is clothed in a diffusing bowl, with lines in relief that add to its appearance, but which do not greatly effect the efficiency. Even while the unit is not lighted, the fixtures add to the lines of the car and break the otherwise practically plain ceiling. The L-182 unit is more of a luminous than a semi-indirect fixture, as a reflector is placed in the base of fixtures which is

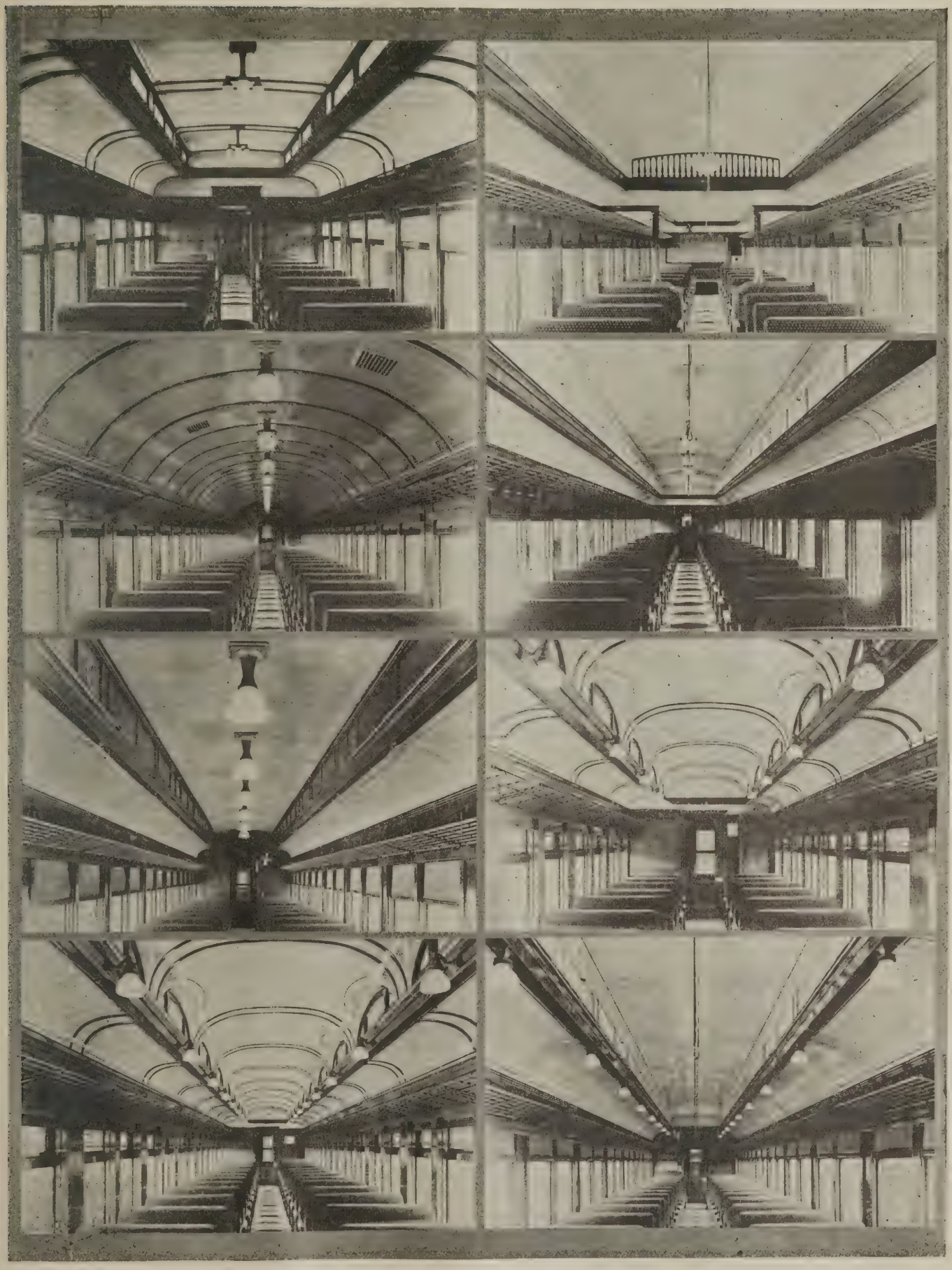


Fig. 3. Typical Installations of Car Lighting Fixtures

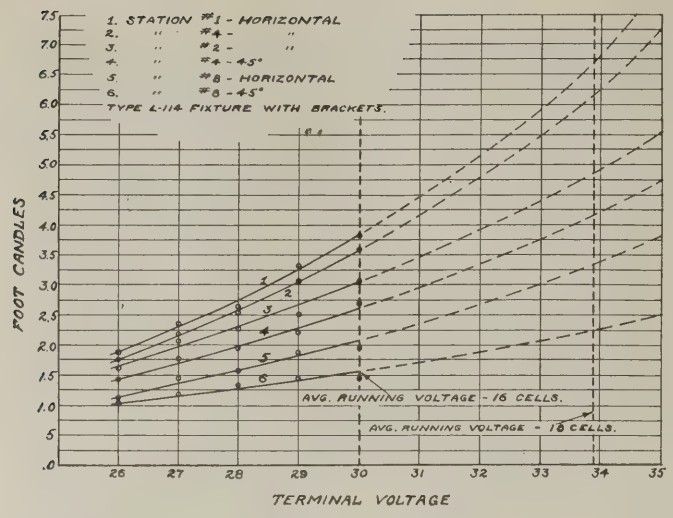

1. STATION #1 - HORIZONTAL
2. " #4 - "
3. " #2 - "
4. " #4 - 45°
5. " #8 - HORIZONTAL
6. " #8 - 45°
TYPE L-114 FIXTURE WITH BRACKETS.
AVG. RUNNING VOLTAGE - 16 CELLS.
AVG. RUNNING VOLTAGE - 18 CELLS.
FOOT CANDLES
TERMINAL VOLTAGE

Fig. 4. Curves Showing Relation of Terminal Voltage to Foot Candles for Observation Room Car Equipped with Type L-114 Fixtures

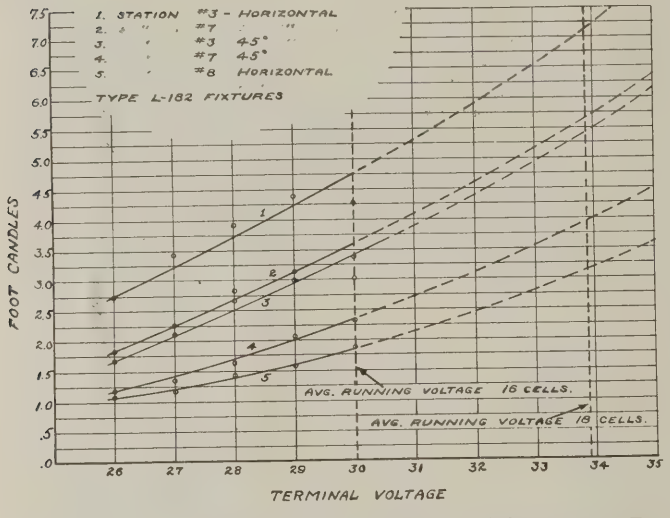


Fig. 5. Curves Showing Relations of Terminal Voltage to Foot Candles for Composite Car "Watsontown" Equipped with Type L-182 Fixtures

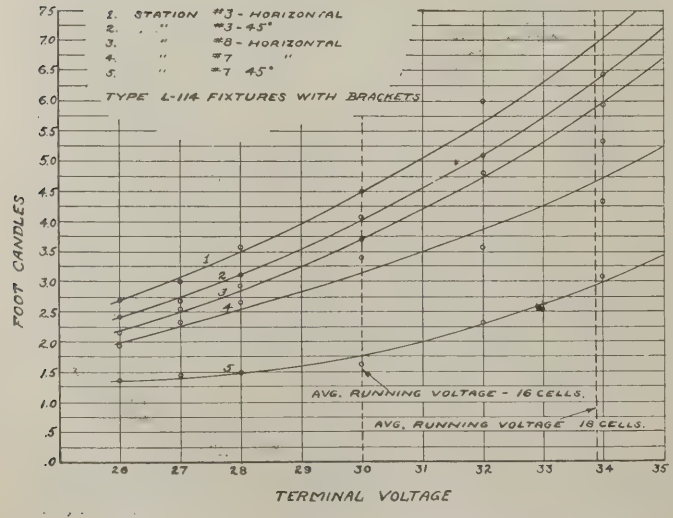

1. STATION #3 - HORIZONTAL
2. " #3 - 45°
3. " #8 - HORIZONTAL
4. " #7 "
5. " #7 45°
TYPE L-114 FIXTURES WITH BRACKETS
AVG. RUNNING VOLTAGE - 16 CELLS.
AVG. RUNNING VOLTAGE 18 CELLS.
FOOT CANDLES
TERMINAL VOLTAGE

Fig. 6. Curves Showing Relation of Terminal Voltage to Foot Candles for Composite Car "Hillcrest" Equipped with Type L-114 Fixtures

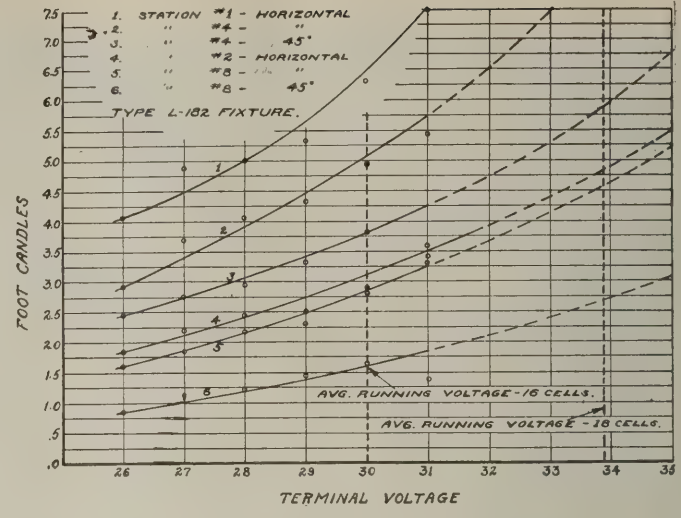

1. STATION #1 - HORIZONTAL
2. " #4 - "
3. " #4 - 45°
4. " #2 - HORIZONTAL
5. " #8 - "
6. " #8 - 45°
TYPE L-182 FIXTURE.
AVG. RUNNING VOLTAGE - 16 CELLS.
AVG. RUNNING VOLTAGE - 18 CELLS.
FOOT CANDLES
TERMINAL VOLTAGE

Fig. 7. Curves Showing Relation of Terminal Voltage to Foot Candles for Observation Room Car Equipped with Type L-182 Fixtures

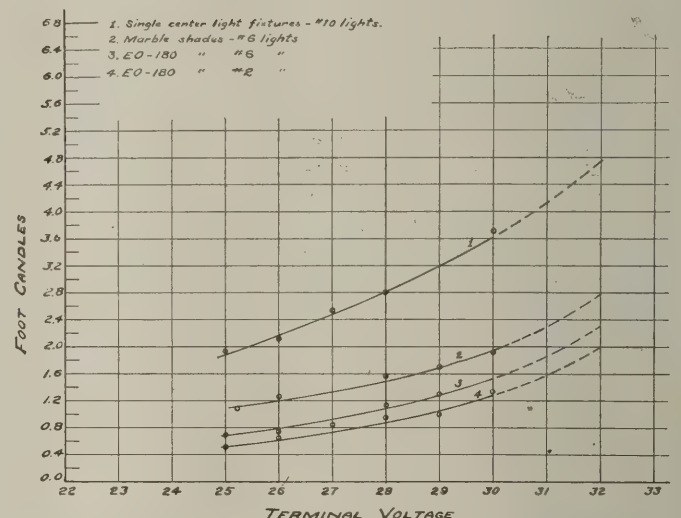


Fig. 8. Curves Showing Relation of Terminal Voltage to Foot Candles. Values Taken at Station 13

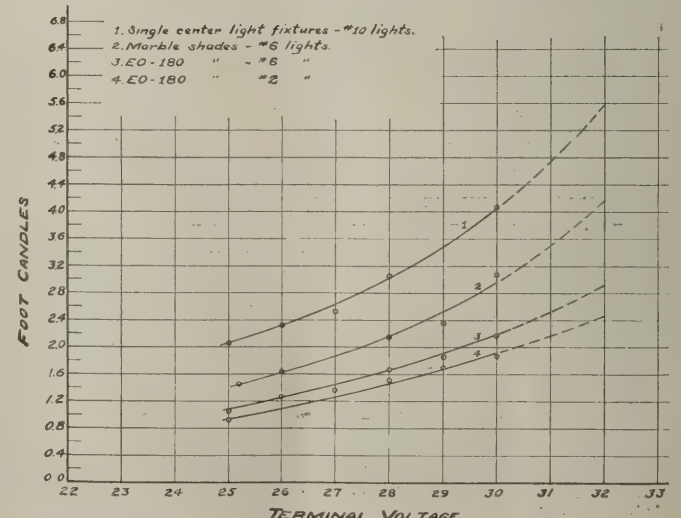


Fig. 9. Curves Showing Relation of Terminal Voltage to Foot Candles. Values Taken at Station 14

mounted directly on the center deck. Thus the ceiling is not used as a reflecting surface to an appreciable extent.

For car work in general, it is not believed that the walls and ceilings can be kept in such condition that they can be depended

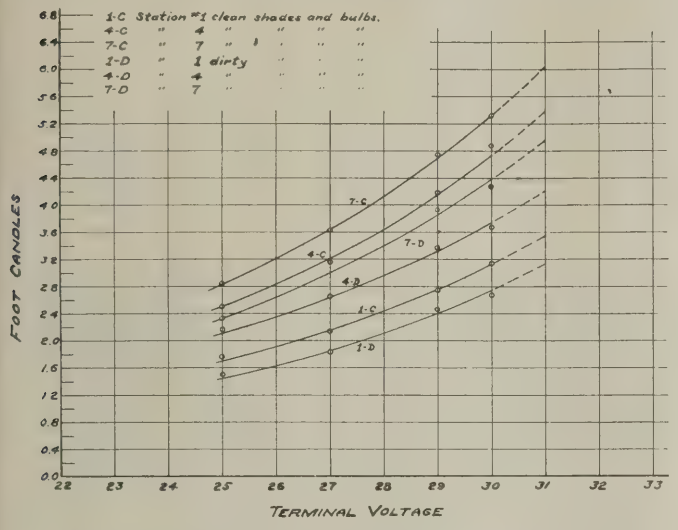


Fig. 10. Curves Made to Show the Effect of Keeping Shades and Bulbs Clean. Readings Were Taken on Illumination, Car "Haverford," Plan 2410 Steel Sleeper, Equipped with Marble Shades

upon to reflect a perceptible amount of light when we consider the quantity of light that they receive.

Determination of Intensity of Illumination Required

Aside from the general illumination necessary, the use of special lighting is for reading, and the lighting system should be so

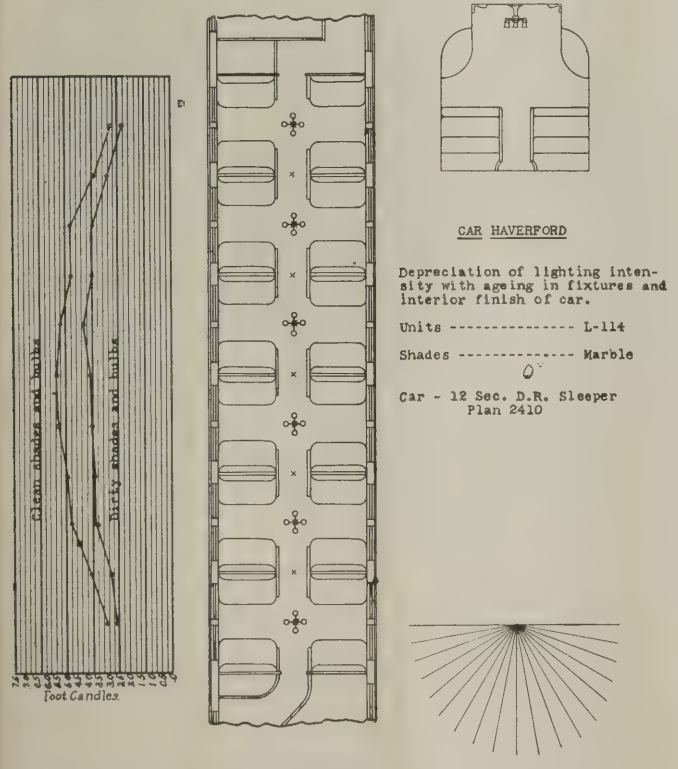

Clean shades and bulbs
Dirty shades and bulbs
Foot Candles.
CAR HAVERFORD
Depreciation of lighting intensity with ageing in fixtures and interior finish of car.
Units ---------- L-114
Shades ---------- Marble
Car - 12 Sec. D.R. Sleeper Plan 2410

Fig. 11. Plan of Car "Haverford" and Lighting Distribution Curves, Taken Before and After Cleaning Shades

designed as to give proper illumination on the reading or reference plane, which is 45 degrees to the horizontal and at right angles to the center line of the car and approximately 33 in. from the floor.

For coach work, owing to design and construction of cars, two methods of lighting are available as before stated as regards the placing of the lamps. They may be hung from the roof in a single row down the center line of the car or a row may be placed on each side of the deck directly over the seats as shown in Fig. 3. The single row is to be recommended on account of the fewer number of fixtures used and the lesser number of lamps.

Another consideration is that with side lighting shadows are

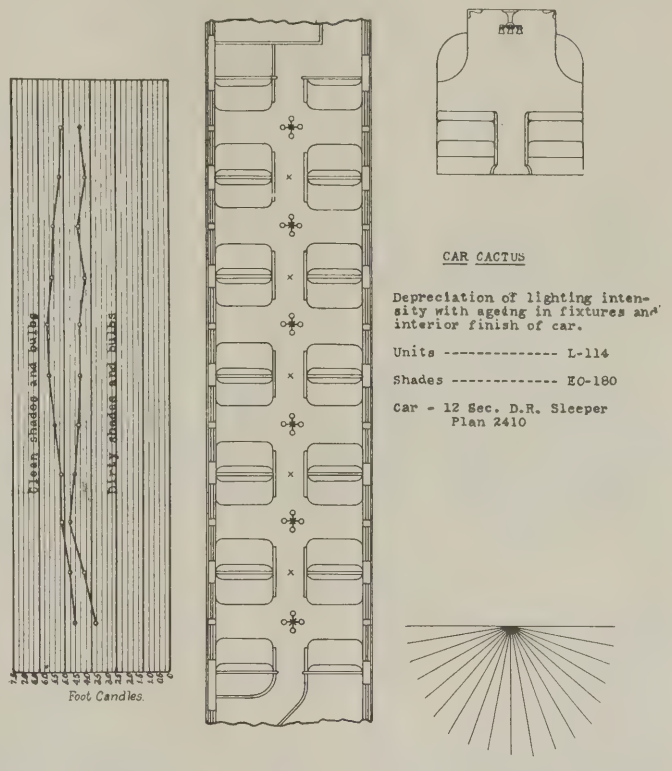

Clean shades and bulbs
Dirty shades and bulbs
Foot Candles.
CAR CACTUS
Depreciation of lighting intensity with ageing in fixtures and interior finish of car.
Units ---------- L-114
Shades ---------- EO-180
Car - 12 Sec. D.R. Sleeper Plan 2410

Fig. 12. Plan of Car "Cactus" and Lighting Distribution Curves Taken Before and After Cleaning Shades

likely to be cast by a passenger's head which will interfere with the proper illumination of his or another passenger's reading matter. This occurs with center lighting only when passengers are standing in the aisles. By placing the center units 6 ft. apart and using lamps with an output of 500 lumens per lamp 3.2 foot-

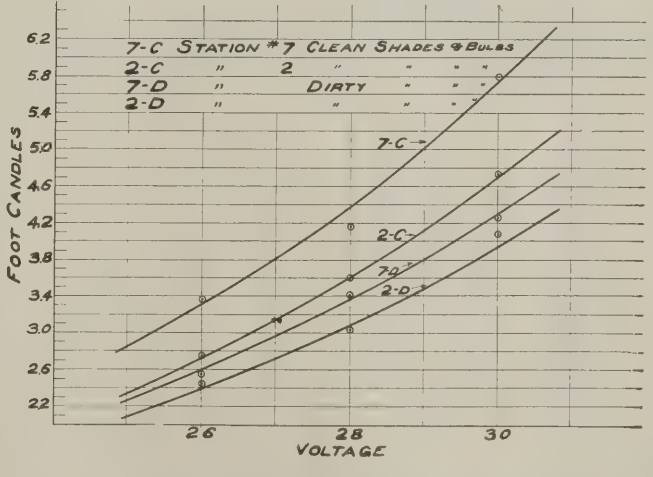


Fig. 13. Curves Made to Show the Effect of Keeping Shades and Bulbs Clean. Readings Were Taken on Illumination, Car "Cactus," 12 Section, D. R. Sleeper, Equipped with E-O-180 Shades

candles can be obtained on the reading plane. For side lighting the same results may be obtained with 250 lumens per lamp. This allows for a depreciation of 40 per cent in the efficiency of the lighting system before the illumination drops to 1.5 foot-candles.

Direct lighting with a shade of medium or heavy density is

most satisfactory for coach lighting, as it is much more efficient than either an indirect system or a direct system; a light density shade is not satisfactory, since the walls and ceilings cannot be kept in proper condition to reflect any appreciable amount of the light which falls on them. The direct system with a shade which properly screens the light source, with the darker ceiling and walls affords spaces of low illumination which allow the eye to rest.

Definition of Terms Used in Report

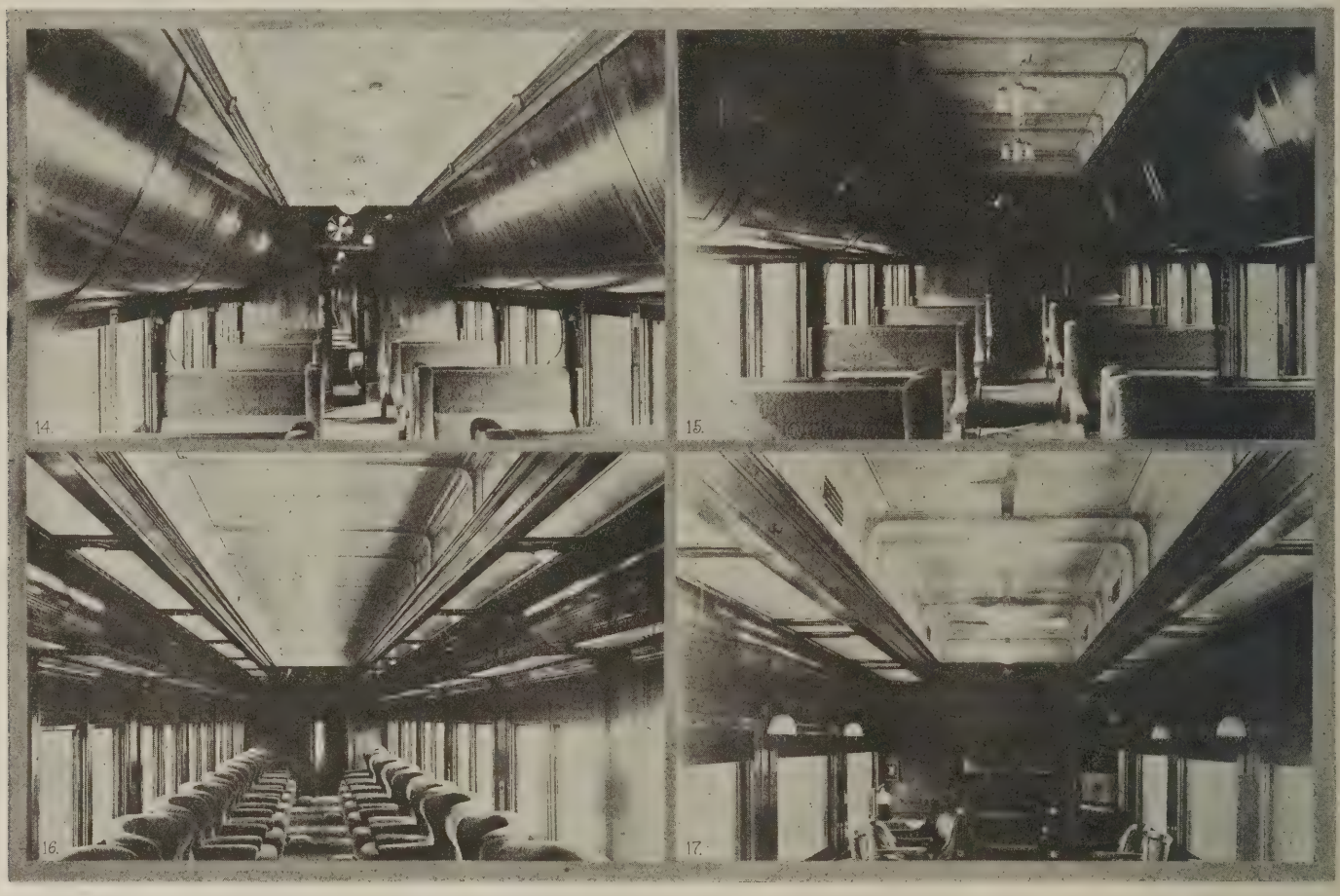
Before taking up the experimental data which is included in this report, definition of terms to be used will be given.

A *lumen* of light flux is the flux emitted in a unit solid angle (Steradian) by a point source of one candle power. (A. I. E. E. Standardization rule 857.) That is, a lumen has been agreed upon which is produced by a one candle power point source, on a surface located just one foot distant from the point source.

(2) An illustration of one foot-candle is that illumination produced on every point on a surface having an area of one square foot if one lumen of light flux is spread uniformly over it.

Reflectors and Glassware

A number of types of reflectors and enclosing units have been developed for car lighting uses. For coach lighting and other classes of cars where efficiency is the primary object and appearance a secondary consideration, the open-mouthed reflector is the one most universally used. Best results are obtained with a reflector giving the maximum candle power at 45 degrees. The following are the principal types of this class of reflectors, to-



Various Lighting Units Used in Pullman Service

Fig. 14. Semi-Indirect Fixture
Fig. 16. Pullman Parlor Car Equipped with L-182 Center Units and L-186 Deck Lamps

Fig. 15. Old Type L-114 Unit
Fig. 17. Semi-Indirect Center Unit Equipment With Bracket Side Lights for Composite or Club Cars

as that quantity of light flux which is radiated in a unit solid angle from a one candle true point source.

A *unit solid angle* is the unit of solid angular measurement. It may be defined as that solid angle, subtended at the center of a sphere of unit radius by a unit area on the surface of the sphere. Also a unit solid angle may be defined as the solid angle subtended at the center of a sphere by an area on its surface, equal to the square of the radius. There are 12.57 unit solid angles about any point in space, that is, any sphere contains 12.57 unit solid angles.

Illumination is the light flux density impinging on the surface of an illuminated object. Illumination is measured by the unit foot-candles. The mean spherical candle power of any *actual luminous source multiplied by 12.57 gives the total lumens generated* by that source.

The foot-candle is the unit of illumination or the luminous flux density. It may be defined in two ways, both of which really means the same thing.

(1) An illumination of one foot-candle is that illumination

gether with the illumination obtained and the efficiency using a 6-ft. spacing, giving 66 2-3 generated lumens per running foot of car. (Extract from "Illuminating Engineering Practice," by George H. Hulse. Source, A. R. E. E. Day Coach Test.)

REFLECTORS	Average illumination on 45 degree reading planes, ft. candles			Illuminating Efficiency on 45 degree plane
	Aisle Seats	Window Seats	Average	
Prismatic clear	2.66	2.17	2.42	34.2
Heavy density opal	2.41	1.87	2.14	30.3
Medium density opal	2.00	1.65	1.83	25.9
Prismatic satin finish	1.94	1.50	1.72	24.3
Light density opal	1.79	1.52	1.66	23.5

Where appearance is the primary consideration, enclosing units are used, and the energy efficiency somewhat sacrificed.

The following results are obtained with this class of unit under conditions similar to those stated above:

ENCLOSING UNITS	Average illumination on 45 degree reading planes ft. candles			Illuminating Efficiency on 45 degree plane
	Aisle Seats	Window Seats	Average	
Light density opal	1.09	0.97	1.03	14.6
Shallow prismatic reflector with light density bowl	1.39	1.09	1.24	17.5
Reflecting and diffusing globes	1.44	1.24	1.34	19.0
Semi-indirect	1.56	1.24	1.40	19.8
Total indirect	1.36	1.11	1.23	17.4
Bare lamp	1.17	1.13	1.15	16.3

All of the foregoing are for electric light. For gas lighting the following results were obtained, the generated lumens being 130 per running foot of car.

ENCLOSING UNITS	Average illumination on 45 degree reading planes ft. candles			Illumination Efficiency on 45 degree plane
	Aisle Seats	Window Seats	Average	
Deep prismatic reflector and bowl	3.65	3.72	3.69	26.8
Reflecting and diffusing globes	2.74	2.34	2.54	18.4
Medium density opal globes	2.08	1.52	1.80	13.1
C.R.I. diffusing globes	1.92	1.67	1.80	13.1

Aluminized metal reflectors are in very general use in postal and baggage cars due to their high efficiency and durability.

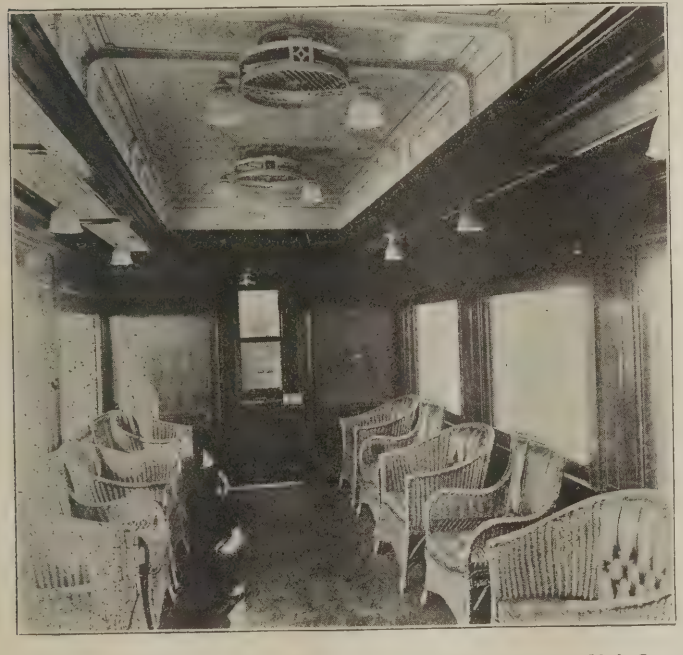


Fig. 18. Equipment as Shown in Fig. 16 for Composite or Club Cars

Standard Car Committee of the Post Office Department specifications for lighting which must be met in every postal car.

LOCATION OF TEST	FOOT CANDLES	
	Minimum	Maximum
Bag rack portion, center of car—horizontal	3.75	12.00
Mouth of bags, measured 18 in. from side of car—horizontal	2.00	12.00
Letter cases, over table—horizontal	3.75	19.00
Face of case—vertical	1.66	19.00
Storage portion	2.00	12.00

At this time it is deemed advisable to call attention to the variation in light flux density on the reference plane with the variation in terminal voltage. It is evident from tests conducted, which data is shown in Figs. 4, 5, 6 and 7, that even increasing the voltage at the lamps by one volt (say from 30 to 31) the foot-candles available on the reference plane is increased approximately 17 per cent. These curves also show a comparison between the old type units used in Pullman service and latest fix-

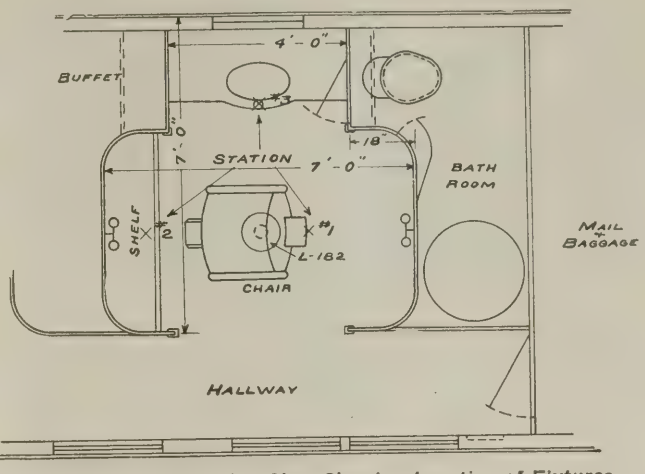


Fig. 19. Plan of Barber Shop Showing Location of Fixtures

tures, the L-182, which units, it should be remembered, are equiuped with 100-watt type "C" lamps; therefore, the watt consumption per unit has not been increased. In the near future investigation will be made to determine whether a 75-watt gas-filled standard lamp could not be used advantageously in place of the 100 watt. Figs. 8 and 9, with the same watts per square foot of illuminated space, the increase in efficiency (at 30 volts) as relates to the L-182 unit, is 89 per cent over the marble shade. (Four-light cluster, 25-watt Mazda bulbs.) Maintenance cost with the L-182 fixtures is reduced. The original price of fixtures is also less than when the older type units were used. Again, with the L-182 fixtures, the color of head lining does not make such an appreciable difference. The decrease in efficiency with the aging of fixtures is not as marked; also, the color of walls in

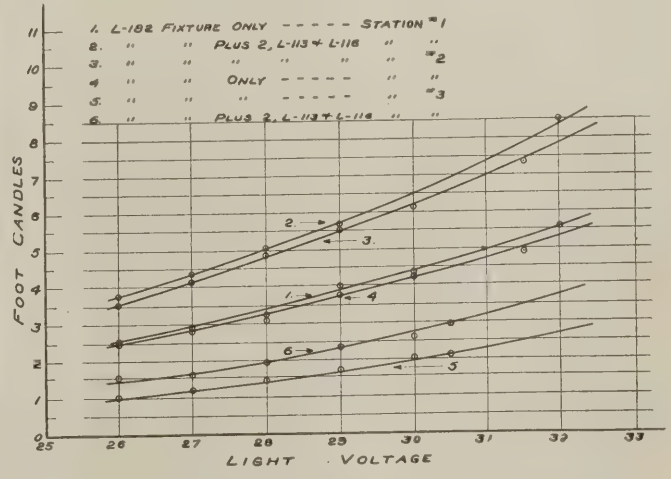


Fig. 20. Curves Showing Relation of Terminal Voltage to Foot Candles for Barber Shop Lighting

a Pullman car adds to the visual acuity of the eye. It was brought out that possibly there would be excessive heating in this type of unit, but from experience this has not been at all detrimental.

Tests were made to determine the decrease in intensity of light in cars due to blackening of shades and bulbs. These tests were made on cars Haverford and Cactus with marble and EO-180 shades, respectively, to determine to what degree blackening of shades and bulbs, due to service and infrequency of cleaning, decreases the luminous intensity.

The tests were made with these shades and bulbs as found on inspection. Then the shades and bulbs were thoroughly cleaned

with soap and water and new set of readings taken. In both these cars the shades and bulbs were in a typical condition as regards cleanliness.

All readings were taken with the test plates horizontal and 33 in. from the floor. The location of stations and the variation in light intensity are shown graphically in Figs. 10, 11, 12 and 13. The decrease in lighting due to lack of proper and frequent cleaning is greater than would be deemed possible. The average increase of intensity in lighting in body of car when shades and bulbs were washed was 25.5 per cent in car Haverford or 26.6 per cent in car Cactus. In the vestibule of the latter the increase averaged 100 per cent. In other words, after cleaning, the fixture itself was twice as efficient. The illumination for various types of cars will now be considered.

Fig. 21. Dining Car Equipped with Indirect Center Fixtures

Illumination of Sleeping Cars

Sleeping cars require lighting for general illumination, for reading or work at the tables in the sections and for illumination of the berths after they have been made up. General illumination is now obtained by the use of luminous fixture (L-182) along center line of car located on ceilings. These units obviate any glare as the Berylite bowls are of such a density as to render the filament indiscernible. Even at the seats for reading or working, these fixtures maintain an average illumination of at least four foot-candles on the reference plane. The traveling

Fig. 22. Dining Car Equipped with Indirect Center, Deck and Bracket Fixtures

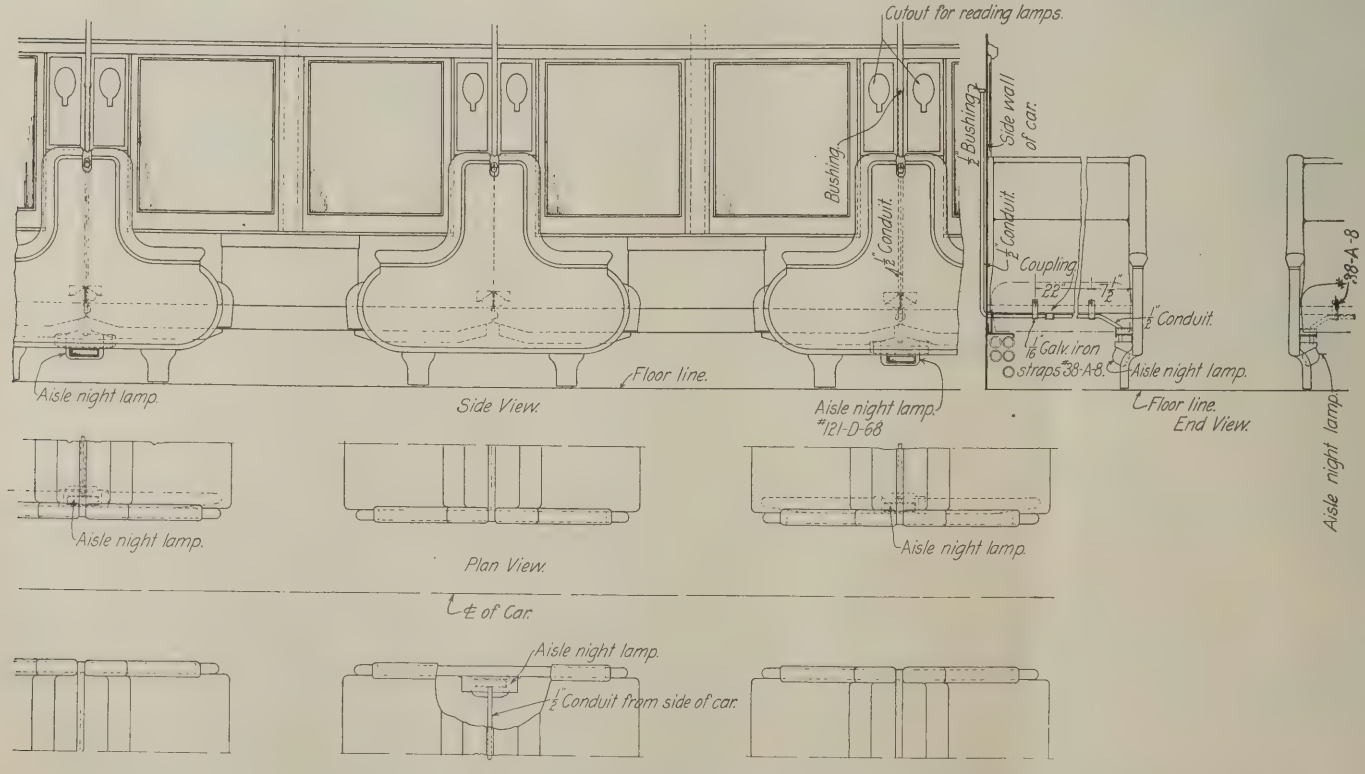


Fig. 23. Plan Showing Location of Aisle Night Lights at Alternate Seats

public seems to heartily co-operate in the statement that at last they have a sufficient amount of light for eye comfort.

The L-173 reading lights (a practically enclosed unit) mounted in the side panels between berths furnish the specific light as an aid to reading. These units, combined with the upper berth lamps, furnish illumination for berths when made up. The various lighting installations used in Pullman service are illustrated in Figs. 1, 2, 14, 15 and 16. The older L-114 unit is shown in Fig. 15 and a semi-indirect fixture is shown in Fig. 14. With this latter fixture, we believe the maintenance cost would be excessive.

Illumination of Parlor Cars

The problem of illuminating parlor cars is not so difficult, as the light intensity on the reading plane is, to a certain extent, within control of the passenger, due to the revolving seat. General illumination is obtained from fixtures located down the center line of car. In addition to the general illumination, reading lights are also provided. These lights are placed on the half deck approximately on the center line of the chair. The above arrangement is applied to Pullman cars of this type and is shown in Fig. 16. The fixtures are of Pullman manufacture, L-182, center, and L-186, deck lamps, respectively. It will be noted that the fixtures in themselves harmonize with the general appearance of the interior of the car.

Illumination of Composite or Club Cars

The proper illumination of composite or club cars presents a relatively difficult problem, for the reason that the chairs are so arranged that the occupant faces the center of the car. General illumination is best obtained by the use of a few center lamps, but as these do not properly illuminate the reading plane it is necessary to supplement them by the use of bracket lights placed on the side of the car behind the chairs, or, if the construction of the car permits, by the use of small fixtures on the half deck, these to be preferably of the same design as the center lamps, but in any case the two should properly harmonize. In Pullman cars of this type general illumination is secured by the use of L-182 center lamp fixtures supplemented by L-186 deck lamps for illuminating the reading plane. This is accomplished by two of the railroads, as shown in Figs. 17 and 18, while an idea of the corresponding Pullman lighting may be obtained from Fig. 16, showing a late model parlor car.

A lighting test was made in the barber shop of composite car Watsontown, result of which test will be given. The lighting system in this car in barber shop consists of one L-182 fixture, containing a 100-watt lamp, two L-113 fixtures with 15-watt No. 2 lamps and one L-116 fixture containing a 15-watt clear lamp. The location of these fixtures is given in Fig. 19. The outline of the room is very irregular, as can be seen from Fig. 19. There is only one small window in the room proper, which is of translucent glass. The hallway windows are of the general type. The walls have a dark mahogany finish which sacrifices the luminous efficiency, but this, to some extent, is compensated for by keener visual acuity. The generally accepted intensity for such rooms used for this type of work requires a minimum of six-foot candles on the working plane. Curves plotted from data are given in Fig. 20. Taking 30 volts as the average running voltage on the lights, the desirability of having bracket lamps as well as L-182 fixtures is readily seen. Also, it must be remembered that the barber on the train is working under more difficult conditions when only the L-182 fixtures are used, since, due to the irregularity of the room, he is continually in his own light and objectionable shadows are produced. Therefore, it is evident that besides the general illumination furnished by the L-182 unit, smaller bracket lamps must be used to practically eliminate detracting shadows.

Illumination of Dining Cars

Dining car lighting is in a different class from other types of cars and it is in the dining cars that most of the novelties in lighting are used. Obviously, the table is the most important item in the car and a high illumination must be concentrated on each table, although a fairly high general illumination has been found necessary so that the car represents a cheerful appearance to the person entering it. Installations with a high intensity on the tables obtained from general illumination have not been found satisfactory. Good general illumination can be obtained from center fixtures mounted on the center deck either when direct or indirect fixtures are used. For specific illumination, fixtures should be mounted over each table. Figs. 21 and 22 show two different types of dining car lighting where all the general illumination is furnished by throwing the light against the ceiling, from which it is reflected to the reference plane.

Aisle Night Lights

The latest development in car lighting is the aisle night lights, which are used to illuminate the aisle at night so that when the center lights are turned off passengers may readily discern their berth numbers or so they will not stumble over any excess baggage that might be in the aisles.

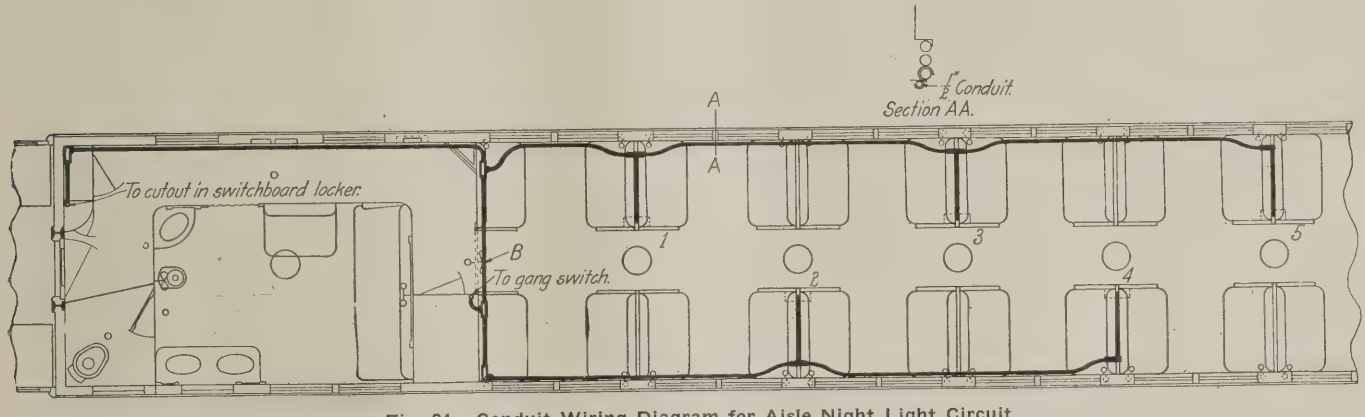


Fig. 24. Conduit Wiring Diagram for Aisle Night Light Circuit

This illumination is secured by means of placing aisle night lamps on alternate seat ends, as shown in Fig. 23, wiring diagrams per Fig. 24. A ten-watt straight side bulb is used which throws the light through a green glass opening upon the carpet. The emitted green light is only partially reflected from carpet and is not objectionable, as no great amount passes to the lower berth.

Postal Car Lighting

The lighting of postal cars has offered a field for intensive study and it has been admirably covered by the report, "An Analysis of Light Distribution Requirements in Postal Car Lighting," which was submitted by Arthur J. Sweet, consulting engineer, Milwaukee, Wis. Persons interested in this type of lighting should secure this report for their own information, as it presents admirably the peculiarities and requirements for proper postal car lighting.

While aluminized metal reflectors have heretofore been largely used in postal and baggage car service, largely due to the results of above tests, experience has shown they are entirely unsuitable for railway service on account of the rapid deterioration of the reflecting surface. In this connection it has been brought to our attention that the Safety Car Heating & Lighting Company have brought out an all aluminum reflector known under the trade name of "Alukali." This reflector has practically the same efficiency and distribution as the aluminized reflector and from such data as we have been able to gather it appears to be

standing up in service very well. It is easily cleaned and deterioration seems to be very slow.

Committee on Illumination—J. E. Gardner (electrical engineer, C. B. & Q.), chairman. Sub-Committee "A," Car Illumination—Ernest Lunn (chief electrician, Pullman Co.), chairman; L. S. Billau (assistant electrical engineer, B. & O.); E. S. M. Macnab (electrical foreman, Canadian Pac.); L. C. Hensel (electrical engineer, St. L. & San F.); E. Wanamaker (electrical engineer, C. R. I. & P.); F. J. Hill (chief electrician, M. C.); A. E. Voigt (chief electrician, A. T. & S. F.); A. H. Gerald (engineer assistant).

Discussion

The report of Sub-Committee "A" on Car Illumination was read by E. Lunn of the Pullman Company. Mr. Billau opened the discussion on this report by saying that during the last four or five years practices in the lighting of cars had undergone considerable change.

Lighting values have increased very much and while the lighting of coaches is not equal to that of Pullman cars the question has been asked by the public why it is not. Is it possible to get more illumination without making a radical change in the fixtures? Is the so-called opal lamp desirable or feasible? If possible the association should try to look forward into the next few years in the way of general development of coach lighting.

Mr. Gardner said that he believed the time was fast coming when more illumination would be required for coach lighting.

Mr. Hack of the Southern Pacific stated that in some diners and observation cars equipped with combination fixtures they had removed these and substituted 75-watt lamps and had improved the lighting considerably.

The question of using colored bowls was brought up by Mr. Moore, Mr. Lunn told about making some experiments with amber colored bowls. In the first experiment of this kind the amber color had been too deep and although it produced a very pleasing effect, the illumination was not good. When it was tried again with a lighter shade of amber the effect was not pleasing at all and they had not experimented any further.

F. J. Hill of the Michigan Central pointed out that nothing had been done in the way of improving the lighting of diners and baggage cars and he thought it would be a good idea to confine the investigations of the association to these cars.

Mr. Wanamaker said that perhaps the white mazda lamp could be used satisfactorily in baggage cars without changing the fixtures and that perhaps it might be a good idea to try them out.

Design and Operation of Railroad Stationary Power Plants

Good Power Facilities Are of Utmost Importance to the Successful Operation of Railroad Shops

Your committee considers it desirable to approach the subject of "Railroad Stationary Plants" from the standpoint that the design, installation and operation of these facilities deserve just as much thought and study as the design, construction and operation of any of the railroads or largest units of motive power. The report has been divided into seven sections or chapters, which are as follows:

Chapter 1: Classification of Plants.
Chapter 2: Design and Installation of Plants of less than 1500 Boiler Horse Power Rating.
Chapter 3: Design and Installation of Plants of 1500 Boiler Horse Power Rating or over.
Chapter 4: Operation and Maintenance of Railroad Stationary Plants.
Chapter 5: Special Fuels and Methods in Boiler Furnace Operation.
Chapter 6: Power Plant Organization.
Chapter 7: Centralization of Power and Its Possibilities.

Chapter I—Classification of Plants

The object and purpose of any railroad is to provide economic transportation of freight and passengers. To accomplish this it is first necessary to have adequate motive power and rolling stock; a right of way, track, etc., over which the equipment may operate. With the foregoing requirements accounted for, that is, the necessary equipment to move the freight and passengers, then the second most important feature is to provide the facilities necessary for the maintenance and repair of the motive power and rolling stock. Such maintenance facilities require, in almost every case, energy in the forms of heat, and mechanical and electrical power. And here is where the stationary power plant is to be considered. Thus it is seen that the stationary plant is of prime importance in the consideration of railroad maintenance facilities, and maintenance facilities are of prime importance in the operation of any railroad.

Stationary plants can be classified as follows:

(1)—Large plants with back shop facilities for heavy repairs, having a capacity of about 50 locomotives per month. There would probably be one to two of such shops on the average sized railroad.
(2)—Plants having shop facilities for light classified repairs, having, on the average, a capacity of about 10 engines per month.
(3)—Division terminal points where light running repairs are made, and the usual turning of power.
(4)—Very small plants, such as pumping stations and in a few instances, coal chutes.

While the design and operation of all of these classes of plants would have many points in common, each class would also have conditions and requirements peculiar unto themselves. And each individual plant would present problems that would have their own peculiar solution. Thus, it is impossible to write a set of hard and fast rules covering the installation and operation of all of such plants, and go very much into detail. But it is possible to establish rules and standards that will apply in a general way to all classes of railroad stationary plants.

Before proceeding further, it is essential to consider just what a railroad stationary plant is supposed to do; just what facilities it is supposed to accommodate and furnish. These factors are as follows:

I—The production of power.
- 1—Generation of electrical power.
  - a—Shop motors.
  - b—Turntable motor and transfer table motor.
  - c—Coal chute motor.
  - d—Welders.
  - e—Signal service.
  - f—Lighting service.
- 2—Generation of mechanical power.
  - This is covered in (1) above in such plants where electrical power is not used or only used for part of the power facilities.
- 3—Compressing of air.
  - a—Rip track.
  - b—Shops.
  - c—Raising or lifting sand.
  - d—Cleaning coaches.
- 4—Pumping.
  - a—Circulating pumps.
  - b—Wash-out and fill-up plant.

II—Blowing engines.

III—Heating.
- 1—A—For 12 months per year.
  - a—Oil house.
  - b—Sand house.
  - c—Washing engines.
- 2—B—Winter load.
  - a—Building heating, including roundhouse, shops and offices. (Exhaust steam.)
  - b—Coach heating. (Live steam.)

The foregoing covers nearly every class of service required of a stationary plant for all classes of plants, including class (1) Plant with large back shops where the production of power would be large in percentage of the total service, down to the pumping station where pumping would be 100 per cent of the service.

Now it is essential to consider what the distribution of service would be in the four classes of plants, as enumerated above, re-

membering that such figures are only average and may vary considerable for each individual installation. The following figures are offered, based on the assumption that all required power is generated at the plant and all available exhaust steam is used for heating.

			Summer	Winter
(1)—Large plants with back shop facilities for heavy repairs.				
I—The production of power			81%	68 %
1 and 2—Electrical or mechanical	28.5%	24 %		
3—Compressing air	47.5%	40 %		
4—Pumping	5.0%	4 %		
II—Blowing engines			14%	12 %
III—Heating			5%	20 %
1—Live steam	5 %	4 %		
2—Exhaust steam	0 %	16 %		
Total 2500 rated boiler horse-power			100%	100 %
(2)—Plants having facilities for light classified repairs.				
I—The production of power			32%	24.5%
1 and 2—Electrical or mechanical	7 %	5.0%		
3—Compressing air	19 %	14.5%		
4—Pumping	6 %	5.0%		
II—Blowing engines			63%	47.5%
III—Heating			5%	28.0%
1—Live steam	5 %	4 %		
2—Exhaust steam	0 %	24 %		
Total 750 rated boiler horse-power			100%	100 %
(3)—Division terminal points.				
I—The production of power			33%	24.5%
1 and 2—Electrical and mechanical	3 %	2.5%		
3—Compressing air	23 %	17.0%		
4—Pumping	7 %	5.0%		
II—Blowing engines			66%	50.0%
III—Heating			1%	25.5%
1—Live steam	1 %	1.0%		
2—Exhaust steam	0 %	24.5%		
Total 300 to 450 rated boiler horse-power			100%	100 %
(4)—Very small plants, such as pumping stations.				
1—a—Pumping 25 to 75 rated boiler horse-power				100 %

The above figures are based on estimates and tests and may vary with each individual installation. The basis of estimation is:

Five pounds of water per pound of coal—actual evaporation.
For blowing engines—50 boiler hp. per hour per engine.
For heating coaches—3 to 5 boiler hp. per hour per coach.
For power—40 pounds of steam per hp. hr.
For compressing air—0.2 hp. per cu. ft. free air compressed to 100 pounds gauge pressure.
8 to 10 pounds of steam per cu. ft. free air compressed to 100 pounds gauge pressure.
For heating buildings—¼-pound steam per sq. ft. radiating surface.

In a general way, railroad plants may also be divided into two general classes as follows:

(1)—Plants of 1500 rated boiler hp. or over.
(2)—Plants of less than 1500 rated boiler hp.

The reason for this latter classification is that all plants of less than 1500 rated boiler horse power may consistently be of the same general design, using the same type of boiler, etc., but plants of over 1500 rated boiler horse power, approach the central station in design and operation.

Chapter II—Design and Installation of Plants Less Than 1500 Boiler Horse Power Rating

Plants of this size cannot afford the overhead of as many labor saving devices as those plants of larger size. However, there are a few of these devices that may be used, according to the size of the plant.

(1) *Boilers.*—Any plant having a capacity less than 1500 boiler horse power rating cannot economically use water tube boilers. The first cost is too high, and the labor cost necessary to keep the boilers in first class condition is prohibitive. The horizontal return tubular boiler is best adapted for railroad stationary service in the plants under consideration.

The similarities between the H. R. T. boiler and the locomotive boiler are so many that the former is easily understood by railroad men. It is comparatively low in first cost, easy to operate and maintain, and withal, it is hard to find its equal in small plants as an economical steam producer when installed in conjunction with a properly designed furnace.

These boilers should be suspended from lugs rather than set on them. The longitudinal seams should come well above the fire line, and transverse seams should be kept well back of the bridge wall. The units should be of such a size as to give flexibility and with it, economy. The 72 in. by 18 ft. H. R. T. boiler of 150 horse power rating meets all of these requirements. But be sure that after a good boiler is obtained, it is not handicapped by providing a poor setting for it. It should be set not less than 42 in. above the grates, and a combustion chamber built large enough to burn the gases. The bridge wall should be built with at least 14 in. clearance between it and the shell of the boiler, and the bridge wall built vertically downward to the combustion chamber floor. Do not build a toboggan slide from the bridge wall to the combustion chamber floor, because of the decrease in volume thereby. The back wall should be built at least 3 ft. from the end of the boiler. This allows plenty of room for the gases and plenty of room for the workman when the boiler has to be re-flued. With 3 ft. of space it will not be necessary to pull down the rear wall when working on the flues at the back end.

The flat suspended tile arch over the back end has given best satisfaction. It relieves the side and back walls of outward thrust, which is common to the old arched type of construction. With the flat arch, the thrust is all vertically downward on the side walls. About 1½ in. clearance should be allowed between the arch and the rear end of the boiler when setting up. Fill this space with loose asbestos and then the worry over expansion is eliminated.

Build the side walls with plenty of clearance up to the closing-in point (two inches above the top surface of the top row of flues), so that every square inch of water heating surface will be effective. Put on a good cast iron flush front and stay the setting with a few buck stays and through rods. Cover the brick work with a plastic material that will not crack under the action of heat.

Usually air or steam was originally used for blowing. The smoke box doors were opened up, and the hand lance inserted in each flue at a time. Sometimes it was run back through the flue and sometimes it was not. It was a dirty and disagreeable job at best, and one that had to be done when the load on the boilers was light. Just how often it was actually done was a question.

Mechanical soot blowers for H. R. T. boilers are of two kinds. The rear end blower and the front end blower. The former cleans the tubes by blowing with the draft which is good. However, it sets in the back end of the boiler where the temperatures are high. True, it is supposed to be pulled back into a recess after using, where it is out of the direct path of the hot gases, but should the fireman neglect to do this the blower would be burned up, and the boiler have to be shut down for repairs. But suppose the blower was pulled back where it belonged. If operating anywhere near the economical point, the temperature at the back end is high, whether it is in the direct flow of the gases or out of them, and the blower subjected to this high temperature is bound to burn out in time. Also any water blown on the tubes will cause the fire combustion ash to clinker, completely closing up the tubes in time.

The front end blower is fastened to the smoke box doors, and cleans the flues by blowing against the draft, just the same as the old hand lance. But owing to the lower temperatures, the blower can be installed so that its blowing elements are much nearer the flue than in the case of the rear end blower. Also, the temperature at this point should be sufficiently low (if the economy is good) to give little if any trouble by burning out the blower, but in case trouble should occur it is not necessary to shut down the boiler to make repairs to the blower. As soon as the load falls off sufficiently, open the smoke box doors and make repairs. The flues can be blown at any time during the day, irrespective of the load conditions, with comparative ease and cleanliness to the operator.

In installing mechanical soot blowers, be sure that drain valves are placed after the main shut off valve, to be assured that no water is blown upon the flues.

Some success has been obtained by bricking up the combustion chamber clean-out doors. The brick can be torn out easily and replaced at each cleaning of combustion chamber, with little expense. The gain in so doing is two-fold. First, interleakage of air is prevented, and second, a uniform brick wall is presented to the impact of the gases, and no portion of them is cooled by radiation through the cast iron door.

Boilers should never be set with more than two in a battery. One division wall is enough expense to maintain.

In plants where the load requirements do not exceed 20 to 100 boiler hp. the locomotive type boiler or the vertical boiler may be used. There are two important things to remember in connection with the installation of either of these types of boilers. First, provide plenty of ash pit space. This is for two purposes: To allow plenty of room for the admission of air and to provide storage space for a few hours run of ashes. More grates and mudrings have been burned out because ashes piled up against the grate and mudrings, particularly on vertical boilers, than

for any other reason. The second thing to remember is that all boilers of these types should be properly lagged with some good insulating material.

For every 100 sq. ft. of radiating surface, 260 lb. of coal can be saved every 25 hr. by lagging with 1 in. thickness of manganese. A 48 in. vertical boiler has just about 100 sq. ft. of radiating surface. A 36 in. vertical boiler has about 65 sq. ft. of radiating surface.

(2) *Grates and Furnaces.*—In general, each individual plant will have its own peculiar problems of design and operation, and such design should consider the exact kind of fuel to be burned, and furnace design in particular should be governed by fuel conditions. Unfortunately, however, in hand fired railroad stationary plants, the design of furnaces cannot be arranged for a particular kind of coal, but on the contrary, installations must be such as to burn any kind of coal that is delivered to the railroad. Therefore, it is poor engineering to design a plant to burn a particular grade of coal, and burn it most efficiently, and then discover after the plant has been put in operation, that the ever changing fuel conditions have made the price on a particular grade of coal almost prohibitive, and in order to use a more economically available coal, a change in the design must be made or continue to burn the high price fuel at a considerable loss. Therefore, plants of the size under consideration should be designed to burn all grades of coal with average economy, be it slack, mine run, chute droppings, or engine lump. This can be accomplished by setting the boilers high and building a roomy combustion chamber, and installing suitable grates.

The question is, just what are suitable grates? There are on the market today about as many different kinds of grates as there are plants. There are the stationary, the shaking, the rocking, the dumping, the semi-cleaning, the self cleaning, the so-called semi-automatic, and a great number of others. Some are good and some are not so good, still others less than that, but they are all more or less in the state of experimental development as yet, and the average railroad company cannot afford the overhead expense of doing a great deal of experimenting with any of them. A few isolated installations here or there, where they can be ground along for a period of several years, is good practice.

But what is the function of a good serviceable grate? A grate is merely a rack or series of racks on which the coal is placed and held during its process of combustion. Necessarily when the coal is burned, the ash and residue must be cleaned from the grates, whether it be manually with a slice bar and hoe, or mechanically through a series of hand levers and bell cranks. Further than this, a grate must be of such design as to allow a uniform distribution of air to pass up through the grate to continue the process of combustion of the coal. Thus a boiler plate punched full of holes would make a grate, but it would not make a good grate. The air spaces in a good grate must be small enough to prevent the dropping through of fine or slack coal, yet they must be of such design that they will not become clogged up with clinker and ashes. The grate must be of such design that under normal operation, and occasional abnormal operation, the maintenance cost will be low. Also it must be easy to repair, for no plant can afford to shut down to replace a faulty grate bar.

An experienced stationary fireman does not like a dumping grate. He would rather wing over his fires and clean them through the firedoors, and many times this is exactly what he does on a dumping crate. A rocking grate is to be recommended provided the grate bars do not lift too far up into the fuel bed, in which case the fuel bed will be torn up, and the ash and coal all mixed together, which is bound to give trouble by clinkering. The committee has in mind a plant where an interlocking finger grate was installed, which gave considerable trouble, until the engineer reversed every other grate bar, turning the fingers all one way, put a stop on his shaker bar arm so that the grates could not be thrown to a full open position. Today that plant is burning coal with good economy, and there hasn't been any expense for grate repairs in several years; because the engineer did away with the patented idea, which was theoretically good, and applied common sense to the problem. The problem is to decide upon some good, simple and common sense grate. If the open market is not able to furnish what is required, it can be made at foundry price.

(3) *Stacks.*—Steel stacks for the smaller size plants are to be considered a better investment than either a brick or concrete stack. There is much in favor of separate steel stacks for each boiler, or for each battery of two boilers. With such installations there is no need of worry, whether the stack is large enough for additional boilers. It also eliminates trouble with breechings, etc. In general, it might be said that for plants having more than six boilers, it would be good design to use a common stack. However, with plants of six boilers or less, separate or battery (two boilers) stacks are recommended, but in any case build the stacks at least 100 ft. high, for it is easier to reduce the draft with a damper than it is to increase it with a steam blower.

Each boiler, whether having its own stack or connected to a common stack, should be equipped with a damper, and a device for controlling the damper. This device does not need to be more than a light ½ or ⅝ in. round rod, operating on a quadrant from the front of the boiler.

(4) *Boiler Fittings and Piping.*—Inasmuch as the A. S. M. E. code is going to be adopted universally sooner or later for all boiler installations, it would be well to get in line now, and make all of our installations conform to the code. Since the A. S. M. E. code requirements are familiar to all by this time, it is not necessary to go into detail on this subject. However, care should be taken in the selection of boiler fittings. Since service is of first consideration, the first cost of such fittings should not be given too much weight in the selection. Valves that are easily repaired and give the best service for all conditions, should be the ones selected, and usually such equipment is not the cheapest in first cost.

The piping should also receive careful consideration and due allowance always made for expansion. Boiler nozzles should be connected to steam headers by steam loops of easy bends, and should enter the header at the top. Steam lines taken from the headers for various points of distribution should also connect to the header at the top with a loop of easy curvature. Blow-off valves should consist of a good grade of extra heavy cast iron, or cast steel. Two valves should always be used for blow-off service, one as a holding valve and one as a blow-off valve.

(5) *Feed Water Heaters and Boiler Feed Pumps.*—Feed water heaters should always be of the open type, in which the water is allowed to rain down over trays, with the exhaust steam rising up in the opposite direction. There are several advantages in this type of heater.

(1)—It is not a pressure vessel, or at least not one of high pressure.
(2)—The steam and water are brought in intimate contact, thus eliminating loss of heat through conducting surfaces such as are found in closed heaters.
(3)—The steam for heating is condensed and is pumped back to the boilers. Thus the amount of scale forming compounds is reduced.
(4)—They are easy to operate and maintain.

Precautions must be taken, however, to prevent an excess of pressure in the heater. This can easily be taken care of by an overflow loop, which not only acts as a pressure relief and safety valve, but also as a positive overflow device. This loop is simply a pipe coil connected to the heater, the top of which is on a level with the overflow point in the heater. It extends vertically downward for 6 or 8 ft., turning upward again to the overflow level, and then downward to discharge into a sewer connection. The total length of the loop does not have to be such as to balance the safe pressure in the heater, but of a convenient length. The principle of the loop is that of a column of water, plus the friction of this water in motion (or surging) balancing the heater pressure. A small ¼ in. pipe in the second bend will prevent the loop syphoning all of the water out of the heater, acting as a vacuum breaker. This device can also be used on the oil trap and at other places on the low pressure or exhaust header where it is desired to drain the water from the line.

To overcome difficulties sometimes encountered with trapped air in the heaters, it is only necessary to run a ¾ or 1 in. pipe directly out the top of the heater. This pipe can extend through the roof, but should contain no valves or other connections. It will act to bleed entrapped air from the heater and will also act as a vacuum breaker.

Besides the cold water connection to the heater, provision should be made to take the discharge from steam traps into the top of the heater. Vacuum pumps should also discharge into the top of the heater as well as cooling water from the air compressors. Every bit of condensed steam returned to the boilers reduces boiler washing cost, and efforts should always be made to return all drips and drains to the heater wherever practical.

Boiler feed pumps should always be installed in duplicate, for upon the continuous feeding of water into the boilers depends the entire operation of the plant. Steam economy in boiler feed pumps is a questionable saving in any railroad plant. The old

duplex pump is always reliable and understood by everyone, and so far as plunger pumps for boiler feeding is concerned, the duplex is to be recommended. Of course, the ideal boiler feed is the centrifugal pump, which will some day entirely supersede the plunger pump for many classes of service.

(6) *Coal and Ash Handling Systems.*—The most economical coal handling system for plants of this size is an overhead track or high line, using dump bottom cars discharging into a storage bin. The floor of the storage bin should be inclined so as to deliver the coal to the fireman in front of the boilers, without rehandling. In plants under 500 boiler hp. rating, the wheelbarrow is about the most efficient ash handling system. Steam jet ash handling systems may be considered in plants of greater capacity.

(7) *Air Compressors and Power Generating Equipment.*—Air compressors for this size plant should be of the two-stage engine driven type. In cases of compressors 2000 cu. ft. capacity or over, the compound steam end is recommended.

Electrical generating equipment may be either reciprocating engine driven or steam turbine driven. For a railroad plant steam turbines are particularly adapted. The low maintenance cost on turbines, and the large amount of exhaust steam required for the winter heating season makes the high steam consumption of turbines an advantage rather than otherwise.

Where the generation is d. c., 250 volts should be used, and when a. c., 440 volts, 3 phase should be used. Alternating current generation is recommended, the amount of d. c. required being easily obtainable with motor generator sets.

(8) *Exhaust Steam Heating System.*—An exhaust heating system is one of the most important and economical parts of those stationary plants which are located in the central and northern territories. It is the one excuse for railroads generating their own power, even when a very attractive rate for power may be offered by central power stations. It is a device or system that is included in the steam using equipment that raises its efficiency from 8 to 80 per cent, and yet an exhaust heating system improperly installed, or improperly maintained, can become the source of more trouble, and the cause of more loss than anything else on the road. A well designed exhaust steam heating system will not require more than 2 to 3 lb. back pressure to operate, and will return condensed water to the boilers to the extent of over 50 per cent of the total water required. However, it is necessary that the exhaust header and mains be sufficiently large, that the heating coils be properly placed, and the return lines be so located as to make repairs easy, with vacuum traps in good working order at all times. It is well to bring the returns back to the power plant separately from each department (roundhouse, shops, offices, etc.), so that trouble can be quickly located by isolating each department, as required, until the trouble is found. Cut all exhaust available into exhaust header. It has even been found that vent pipe from wash out system can be cut into exhaust header through reducing valve to good advantage.

Vacuum pumps should be large enough to take care of the coldest season, and should always be installed in duplicate.

(9) *General.*—See that all steam (high pressure and low pressure) and air lines are covered. See that covering exposed to the weather is again covered with roofing paper and painted. See that all parts subject to any great amount of undesirable radiation is carefully insulated. Build a real plant to start with, and see that it is 100 per cent before it is turned over to the operating department. Confer and co-operate with the operating men in the design and installation of the plant, and if they are provided with a 100 per cent plant with which they are satisfied, the result will be that they will do more towards maintaining and operating it at 100 per cent.

Chapter III—Design and Installation of Plants of 1500 Boiler Horse-Power Rating or Over

A plant of this size can well afford the overhead cost of labor saving devices, and some of the more refined power plant equipment.

(1) *Boilers.*—The boilers should be of the approved safety water tube type, and of such size as to be flexible, and yet sufficiently large to keep the idle investment charge down to a minimum. For the average heavy back shop plant, the units should be of 200 to 350 rated boiler hp. capacity. This type of boiler requires a brick setting, unless steel settings are used, and it might be well to mention here that the railroads have not yet realized the value of steel boiler settings. The material for brick settings should be carefully chosen and only the best furnace brick masons should be allowed to build the settings. A boiler setting is an expensive investment, and unless the best care is given to the building of brick settings, they will crack and crumble, and in only a few months they will require rebuilding. Do not put an air space in the boiler walls with the idea that insulation will be obtained thereby. If space is desired between the fire brick and common brick to allow for expansion, fill up the space with crushed cinders, front end cinders, sand or other insulation.

Poorly built settings represent a great loss of money. Not only is the first cost of the setting almost entirely lost in such a case, but there is a continuous loss in fuel due to great inleakage of air. Further than that, there is a loss in boiler capacity due to inefficient conditions and loss of draft. After the setting is built, it should be entirely covered with a plastic cement, or other material that will not crack under temperatures to which the setting is subjected, and against time.

The question of soot blowers has not been satisfactorily answered with this type of installation, although many experiments have been made. With a plant of this size, usually the force is large enough to keep the tubes well cleaned by the hand lance, and the supervision is sufficient to see that the tubes are kept cleaned.

(2) *Stokers.*—Stokers are one of the labor saving devices that a plant of 1500 rated boiler hp., and over can well afford. The question of the type of stoker cannot be settled by any fixed rules, for the available coal supply will fix to a great extent the style of stoker. However, the chain or traveling grate seems to be a stoker well adapted to the Middle West territory, and has given good satisfaction in a large number of railroad plants. It is easy of operation and repair, and when the units are of such size as to give flexibility of operation, the inflexibility of the traveling grate is overbalanced by its advantages.

(3) *Stack and Draft Devices.*—A well built stack is always a good investment for a railroad plant, provided that the stack is of sufficient size and height to carry any overload that the plant may be called upon to deliver. Force and induced drafts have been tried with varying degrees of success, but natural draft with a well designed stack can be depended upon at all times. Each boiler should be provided with a damper in the connection to the stack or the breeching, so that the boiler can be easily drafted for all conditions of load. Such damper should also be provided with damper control that can be easily operated from the firing floor.

(4) *Boiler Fittings, and* (5) *Feed Water Heaters.*—These subjects are covered in the previous chapter.

(6) *Coal and Cinder Handling Devices.*—In plants of the size under consideration with stoker fired boilers, the coal should be delivered to the stokers from overhead storage bunkers. It can be unloaded from the car to these bunkers with either an overhead crane or a traveling bucket conveyor. With the latter device, the same conveyor can also be used for disposing of the cinders. The ash pits should be located in the floor below the fire room, and should be of sufficient capacity to run 12 hours without cleaning.

(7) *Air Compressor and Power Generator.* (8) *Exhaust Steam Heat System, and* (9) *General.* These subjects are covered in the previous chapter..

Chapter IV—Operation and Maintenance of Railroad Stationary Plants

Once the plants have been installed according to the design which will best suit the needs for continuous and economical service, it is up to the operating department to operate and maintain them economically. The following indicates just what is necessary in order to accomplish the desired result:

(1) *Boilers, Furnaces, Stacks and Boiler Fittings.*—Keeping soot from accumulating on tubes and flues is one of the most important steps towards economical operation. Flues should be blown at least once each eight hours, and when boilers are down for a washout, flues should be thoroughly cleaned with a brush or scraper. In case of water tube boilers, the tubes should be thoroughly blown when the combustion space is cleaned. Men should get inside of the furnace and inside of the combustion chamber and blow this soot. Boilers should be blown down at

least once each eight hours and men coming on shift should test water columns and try cocks, and pop valves.

Practice feeding the boilers continuously, maintaining a constant water level. Regulate the draft with stack damper rather than ash pit doors, according to the load carried.

When boilers are down for a washout be sure that they are cleaned. Rattle or turbine the flues if necessary and scale the shell. Clean out the furnace, and combustion chamber. Clean off the bridge wall and clean out the smoke box. See that all repairs to furnace and combustion chamber walls and arches are taken care of. Be absolutely sure that the boiler is 100 per cent, before putting it into service. Repair blow-off valves and feed valves if necessary. See that smoke box doors and combustion chamber doors are air tight. Minor furnace and combustion chamber repairs can be made with plastic cement. A barrel of this material should be kept on hand at each plant. Air leaks can be stopped up with a plastic boiler covering. A barrel of this material should also be kept on hand at each plant.

Stacks should be painted with an approved stack paint at least once a year.

See that non-return valves are kept in working order, and that all valves are kept packed; painting valve stems with graphite and oil about once a week is a wonderful means of saving valve stem packing. If the insulation is removed from the piping to make repairs, see that it is replaced.

(2). *Feed Water Heaters and Pumps.*—Feed water heaters should be cleaned frequently. The frequency of cleaning can easily be determined by watching the temperature of the feed water. This temperature should never be allowed to drop below 200 degrees. Carry the water level in the heater at such a point as to keep a head of water on the pump at all times, but not so high as to cause the heater to overflow continuously. Don't try to operate the heater without a water glass or thermometer. Always keep a water glass on hand. Both of these are necessary for the intelligent operation of any feed water heater.

Feed water pumps should be repacked once every 30 days. This insures one good pump on the job all of the time. A defective feed pump may mean shutting down the plant.

(3). *Air Compressors and Power Equipment.*—This equipment should have rods and bearings keyed up at all times. Do not allow compressors to run with bad intake and discharge valve. Such equipment needs a general overhauling every three to five years. Inspect water jackets on compressors frequently, for in bad water districts they will fill up with mud and scale very quickly. Indicate all engines and compressors frequently and take care of leaky valves and faulty settings as quickly as possible.

(4). *Exhaust Steam Heating System.*—Unfortunately, this is a part of stationary equipment that seems to be little understood and sadly neglected; yet it is the one big economical device used. It is a fuel saver if there ever was one. Any railroad exhaust steam heating system should operate with satisfaction on two to three pounds pressure—certainly, never more than five pounds. One pound of exhaust steam has about 90 per cent as much heat as 1 pound of pressure steam at 125 pounds gauge pressure, and a well designed and well operated exhaust steam heating system will reclaim about 90 per cent of this, and the greater part of the other 10 per cent goes into the feed water. A vacuum of 5 to 10 in. of mercury should be sufficient to operate any railroad exhaust steam system, provided the return lines are tight and the traps are not leaking.

During the summer of each year all heating system traps and sediment chambers should be removed and cleaned. See that the return lines are all in good shape and air tight, overhaul the vacuum pumps, and this done, there is no reason why the system should not go through the following winter without trouble. However, should occasion arise where it becomes necessary to shut the heat off, even for a short time, be sure that all drains from the system are opened to the sewer to prevent freezing up of coils and lines, and keep them open after the heat is again turned on until you have thoroughly warmed up the system and conditions are normal. Then cut in the vacuum pump.

If loss of vacuum occurs, find out in what section the trouble lies, by isolating each section in turn, then test the pumps by shutting off the returns. The trouble will finally be found to be in the pumps or in some section of the system, such as the roundhouse, shops, office, etc. Having located the section, go over the return lines in this section, with a torch if necessary, for a torch is about the simplest method for locating leaks in vacuum lines. If it is not located in the return lines, then look for a leakage trap. This can be located by shutting the steam valve on each coil in turn. When the exact location of the trouble is found, remedy it at once.

(5). *General.*—See that all steam, air, and water lines and valves are kept in repair. Do not allow pipe covering to become ragged and fall off. Do not allow pipe line supports and hangers to become loose. Keep everything in 100 per cent condition. Keep boiler and engine rooms clean and painted. Do not allow temporary shacks, piping and scaffolds to stand after they have served their purpose. Put in the broken window lights, rehang sagging doors, and paint the walls, piping and foundations. Make the stationary plant a clean and desirable place to work in.

Chapter V—Special Fuels and Methods in Boiler Furnace Operation

It might be well at this time to touch upon the burning of oil, gas and powdered coal in railroad stationary plants. Also to remark upon the use of force draft with hand fired furnaces.

Oil and Gas.—Where these fuels are in active competition with coal, they can be burned with very great economy in railroad plants. There are only a few places where gas is used, and it is not likely that natural gas will ever be used to any considerable extent in railroad plants. This fuel is readily adapted for domestic use and the domestic field is too large and the supply of gas too small to make this fuel very active for commercial purpose. It is, therefore, merely noted in passing. The burning of gas has many similar features to burning of oil. The introduction of air is always through the burner. The user would do well to accept any of the patented gas burners on the market rather than attempting to do any experimenting. The burning of oil in furnace boilers has assumed a very great importance during the past few years, and the continual rise in price of coal is going to make oil an active competitor of coal in the middle western territory.

Steam seems to be the favorite medium of atomization, although low pressure air has been used with very good success. Any burner that will atomize the oil efficiently, with a minimum of steam consumption, will give economical results. There are about as many patented oil burners as there are patented grates, and, as in the case of grates, a home-made burner, constructed on common sense principles, will usually give as economical results as the high priced patented article. However, it is well to remember that oil can be burned, or rather used, more extravagantly than almost any other commercial fuel. The design of furnace has considerable to do with the economical burning of oil. The use of pre-heated air (air usually heated by passing through ducts in furnace and floor, side walls or arches) does much to increase the efficiency of oil burning furnaces. Using oil in R. T. settings, care should be taken to direct the flame downward, for if the flame is allowed to imping upon the boiler shell, particularly in the vicinity of a seam, trouble will always result.

Powdered Coal.—The use of this fuel at this time is not recommended. It is still in the experimental stage, and it would be well to let someone else do the experimenting. The danger in handling and transporting this fuel has always been an argument against its use. It is understood that the plant at Parsons, Kansas, which was the pioneer in powdered coal burning at stationary plants, has abandoned that fuel for oil.

It might be well to mention "Colloidal" fuel in this connection. The United States Shipping Board has been experimenting with this fuel for over a year, and according to all reports, have obtained great results and success thus far. "Colloidal" consists of fuel oil having powdered coal in suspension. The coal remains in suspension without continuous stirring and agitating, by virtue of the colloid added to it. Of course this colloid is the secret of the entire process, and, no doubt, is covered by patents. "Colloidal" fuel burning presents about the same conditions as oil burning. The fuel can be used in the same burners that are used in oil burning processes. It has all the advantages of powdered coal, and none of the dangers in handling and transporting that powdered fuel has. "Colloidal" fuel is heavier than water, and when dumped upon the surface of water, it will sink. In this respect the fire hazard is reduced even over oil.

It would be well for fuel men to watch the progress of this product.

Burning Coal Without Smoke.—The question of burning coal without smoke and the design of smokeless furnaces is always a live one. Smoke is usually an indication of inefficient operation. Notice we say "usually," for there are a number of instances where smoking was excessive, and the efficiency very high. However, smoke is a nuisance and should be overcome if possible without resorting to highly expensive equipment. The process of "white washing" smoke should never be resorted to except in extreme cases. Don't be fooled into believing that by turning large quantities of steam into the furnace or stack that the smoke is necessarily burned or the efficiency increased. This process merely dampens down the smoke. The problem of smokeless combustion merely involves the proper and right relation of air and unburned gases, and the maintaining of a sufficiently high temperature during combustion of the gases. The proper mixing of air and gases usually involves a secondary admission of air, and the maintaining of the sufficiently high temperature is usually accomplished by brick work in the form of secondary arches and bridge walls, wing arches and smoke arches. If secondary admission of air is used, great care should be taken to see that this admission is properly controlled, for greater damage and loss of efficiency may result from the improper use of secondary admission than without it. Also remember that introduction of smoke and secondary arches results in a loss of draft, and make due allowances. The question of "dutch ovens" is one of the first to arise in considering smokeless combustion of coal. But, while "dutch oven" furnaces are recommended in some cases, there are many coals that will not give results in this type of furnace. Furnace temperatures with "dutch ovens" are always high, and with a coal, the fusing point of whose ash is low, extremely high furnace temperatures are undesirable, for they turn the fuel bed into a slag bed of a sticky plastic mass, which cuts off air supply, burns out grates, rends the patience of firemen and engineers and always results in lowered capacities and efficiencies. Keep the furnace temperature as high as is consistent with the fusing point of the ash, but keep the combustion chamber temperatures as high as you can get them. In other words, there are many places where, if the "dutch oven" arch was moved out of the furnace and into the combustion chamber, a saving of fuel and increasing of boiler capacity would be effected.

Forced Draft.—Considering the question of forced draft and regulated forced draft. There is no doubt that forced draft will increase the capacity of any furnace, for it increases the rate of combustion. But, also, forced draft may become the source of great loss of economy, when used inadvisedly, for it is such an easy matter to blow great volumes of excess cold air up the stack. The maintenance of forced draft equipment is also an item deserving consideration. Furnace maintenance with forced draft will be increased.

To overcome the bad features of forced draft, go a step farther and install regulated, controlled or balanced draft. There are several such systems on the market at the present time, and in choosing any one of them be sure to analyze the system completely. First of all there are two points to consider as the basis of regulation: the load conditions, and the furnace conditions, of which the furnace draft is an indication. All of the controlled forced draft systems admit of the steam pressure as a point of regulation for load conditions. This regulation is obtained by a pressure regulator which speeds up or slows down the fan, accordingly, as the pressure drops or rises. As for the second point of regulation, the furnace condition is primary. There is no other condition, or set of conditions, that will serve as good a point of regulation basis as the furnace conditions. So in choosing any of the controlled or balanced draft systems, be sure that:

(1)—The furnace is used primarily as a basis of regulation.
(2)—The control device is simple mechanically and the maintenance not excessive.

Chapter VI—Power Plant Organization

Thus far, a power plant has been installed to suit the demands, a plant designed for continuous and economic operation. It is agreed as to how this plant should be operated and how it should be maintained. Now, it is necessary to provide for an organization to operate this plant. Just what should a power plant organization be? First of all it must have an engineer, a chief engineer, head engineer, boss engineer, engineer in charge, engineer foreman, or call him whatever may be desirable. In any event, he must be the responsible party, and must know:

(1)—Power plant operation.
(2)—Boiler making, sufficiently to know how and when boiler repairs should be made.
(3)—Machinist trade, or have a sufficient knowledge to line up engines, repair and keep up bearings, and know how and when to repair cylinders, valve parts, cross head guides, and face and set valves.
(4)—Carpentry and forge practice.
(5)—Furnace mason work.
(6)—How to handle men.

Besides this he must be a good fuel man, and all for the same wage that is paid to a common laborer, whose every movement is directed. Can such a man be had for that? Absolutely not. It is not so much a question of whether the engineer receives 40 cents an hour or one dollar an hour, for wages are high today, and perhaps low tomorrow. The point to emphasize is the classification of the engineer, and once having him classified, he is, of course, then entitled to the market wage for that class.

The chief engineer should be classified as a foreman; stationary power plant foreman, if you will, and he should be given the authority and responsibility of a foreman, and he should be given the wage of a foreman. In plants of over 1500 boiler hp. rating, he should be a general foreman in charge of all stationary power on the plant, including electrical work. Call him chief electrician, if you will, call him anything you choose, but give him the authority to operate and maintain the power plant, and give him the wage due to his classification.

For plants of less than 1500 and more than 300 boiler hp. rating, the chief engineer should have the same standing and classification as that of the boiler foreman, machine shop foreman, etc.

For plants of less than 300 boiler hp. rating, the engineer in charge should have the rating equivalent to craft journeyman.

And now as to the classification of the watch or shift engineers. They should be directly under the jurisdiction of the chief engineer, and should be classified and paid as craft journeymen. Firemen should be under the jurisdiction of the watch engineer, in absence of the chief engineer, and should be classified as not less than craft apprentices. This is for plants sufficiently large to call for both watch engineers and firemen. In places where firemen are called upon to handle the entire plant, in absence of the chief, the firemen should be rated as craft journeymen. Coal and ash handlers are to be rated the same as all other unskilled labor.

This plan might be extended to a division, in which there would be one division chief stationary engineer, who would be sponsible for all stationary plants on the division, plant engineers and firemen being directly under his jurisdiction, except in the case of large back shops of class 1 (see chapter I), where the engineer would act as general foreman of stationary equipment, reporting directly to the master mechanic or shop superintendent. The division chief stationary engineer would report to the general foreman of the division mechanical forces.

It is believed that there is no railroad, at the present time, where such organization is in vogue throughout, but it is presented as a tentative scheme of organization, which would call the attention of railroad executives to condition of affairs at present, and offer some sort of a plan for the future. At present there seems to be no standard plan of organization in vogue. Most organizations in stationary plants now just seem to have been "dug up" to meet the exigencies of service.

Chapter VII—Centralization of Power and Its Possibilities

The industrial success of this great United States has been due, primarily, to two things: (1) Centralization and (2) Division of labor.

There are not a few central power stations now in operation. Here will be found the very latest words in design and operation, and nowhere as a strictly power proposition, is electrical energy produced any more economically. And yet, the question is asked, why is it that the central states cannot produce energy with as low cost as it is produced in the terminal buildings in Chicago? The answer to this problem is simple enough. It is "by-product." Our terminal buildings produce electrical energy, with steam heat as a by-product, or they produce steam heat with electrical energy as a by-product, as you please. With centralization has become possible the great by-product industries, a point which seems to have been overlooked by central power stations.

Due to that peculiar property known as "latent" heat in steam, we are only able to make available, for electrical energy, not more than 5 per cent of the heat in coal in the average iso-

lated plant, and not more than 20 per cent in the very best central station plants. But by including a heating system on to the small isolated plants the railroads are able to utilize the vast amount of steam in the exhaust, making their plants 30 per cent to 40 per cent efficient, as against the central station's possible 20 per cent. True, central station heating has been tried out with varying degrees of success, but the success has been sufficient to cause the development of bleeder turbines and exhaust steam turbines.

In closing, let us keep in mind the possibility of centralization of the production of power, but bend our efforts towards such economical production of power in our own small plants as is possible, until such time as we no longer have need for these small plants.

Committee: L. C. Bowes (supervisor power plants, C. R. I. & P.), chairman; M. L. Stewart (chief electrician, El Paso & South West); G. F. Harbin (electrical engineer, Washington Terminal Co.); Edw. Kendall (chief shop engineer, C. R. I. & P.), W. J. Barnes (engineer power plants, B. & I., Lines West); Walter L. Wood; G. O. Moores (chief draftsman, B. & O.).

Discussion

L. C. Bowes, of the Rock Island and chairman of the committee on Stationary Power Plants read the report. Before reading it, however, Mr. Bowes stated that the committee had confined itself only to generalities hoping to arouse interest so that further information could be obtained later.

After Mr. Bowes had finished reading the paper Mr. Billau complimented the committee for the preparation of such an excellent report. He said one of the most serious problems today was the operation and maintenance of railroad power plants. It is a question of getting an organization and of keeping it. Plants are often over rated because output is wasted.

There was no discussion of this report by the association members probably because of the fact that the report was very long and covered practically every detail. Moreover, the number of electrical engineers who have charge of the power plants are comparatively few.

Electric Arc Welding and Electric Safe-Ending of Flues

Committee Supplements Work of Preceding Year by Adding a Fund of Up to Date Information

Your Committee considers the subject of Electric Arc Welding of such a broad and growing nature that it felt a complete report at this time is entirely unwarranted. However, in order to provide reliable and practical information for the use of the association and those engaged in electric arc welding on the railroads, the committee has prepared a report in the form of a supplement to the 1918 proceedings containing the Report on Electric Arc Welding, pages 110 to 140, inclusive.

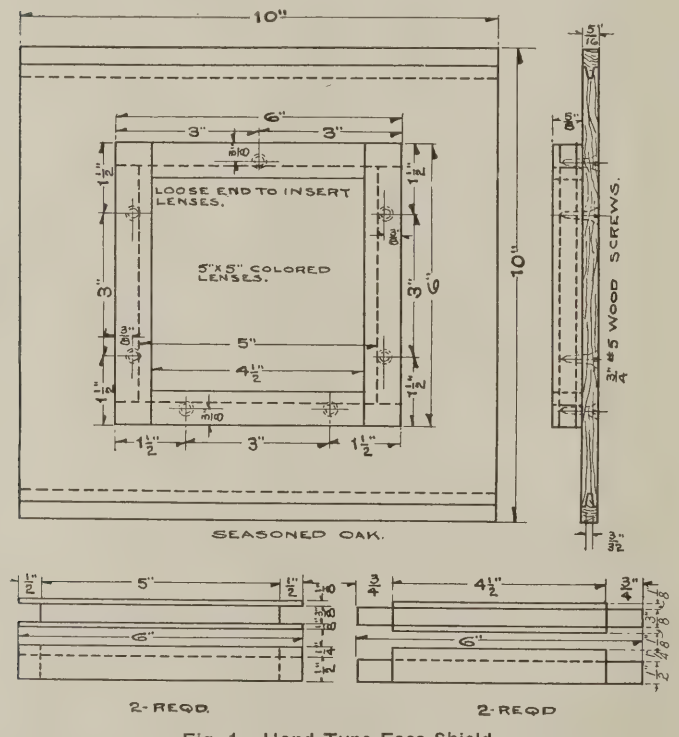


Fig. 1. Hand Type Face Shield

It is the thought of the committee that these reports on electric arc welding should be brought up-to-date from year to year in the form of a supplement so that the association at some future date may consider the printing of a hand book of the entire matter in revised form.

In order to facilitate in the presenting of this report the committee has considered it advisable to refer to various pages, paragraphs and sentences of the 1918 report wherein additional paragraphs, sentences, changes, etc., are considered advisable. Where such changes are made the 1918 proceedings are referred to.

Metallic Arc Welding Equipment

Pages 100 and 101.—An additional paragraph added to the subject, "Metallic Arc Welding Equipment," immediately preceding the last paragraph on that subject. The new paragraph to read as follows:

For track maintenance work and also on certain applications of welding involved on electrified roads, a portable gasoline engine unit may be used. Units of this character are driven by a four-cylinder automobile engine running at a speed of approximately 1,200 r.p.m. The size of welding machine usually used is 150 to 200 amperes. The weight of the outfit complete is approximately 650 lb. In such equipment it is desirable to get the weight down to the lowest possible figure; in that connection the use of the high speed engine, in spite of its relatively short life, offers real advantages. The character of this class of weld-

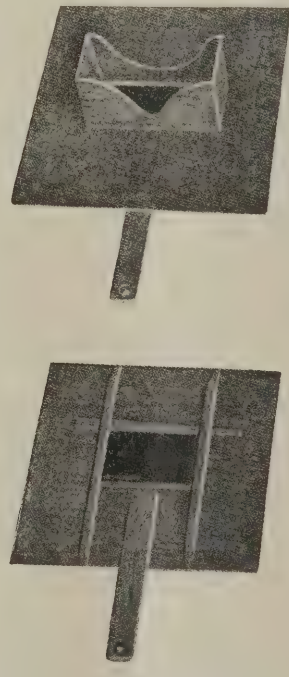


Fig. 2. Hand Type Face Shield with Side Protection

ing is such that continuous day to day service is seldom required, so that notwithstanding the short life of the engine, the equipment is thoroughly practicable.

An additional paragraph added to the subject, "Metallic Arc Welding Equipment," immediately preceding the subject, "Carbon Arc Welding and Equipment." The additional paragraph reads as follows:

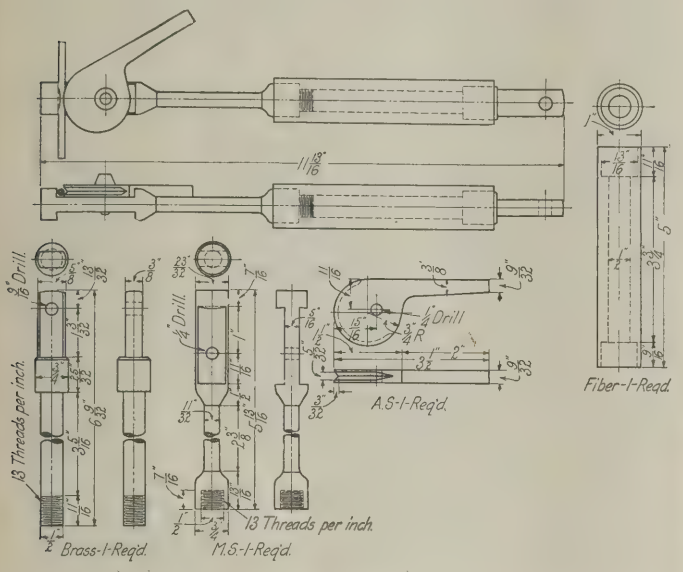


Fig. 3. Construction Details for Metal Electrode Holder

A. C. Welding Equipment.—At the present time there are a number of a. c. welders on the market, but the committee is not in a position to make definite recommendations either for or against the application of this type of equipment for railroad work. At the present time the indications are that a. c. welders will not be especially satisfactory, as the close arc needed for satisfactory operation does not lend itself readily to welding of some of the important jobs in connection with railroad work.

Eye and Body Protection

Page 103.—The subject "Equipment Accessories," heading changed to read, "Eye and Body Protection."

The third paragraph changed to read as follows:

A sketch is shown in Fig. 1 (1918 proceedings) of a shield to be held in the hand and which has been found to be satisfactory. A shield of this type is cooler than the helmet type and as a rule is preferred for "down-hand" welding, since ordinarily this class of welding does not require a free hand to steady the body. A face shield should always be made of material which is a non-conductor. Very satisfactory and inexpensive hand shields are shown in the accompanying illustrations, Figs. 1 and 2. These hand shields can be produced in any carpenter or pattern shop at a very nominal cost. They afford better protection to the eyes from reflected light than any other hand shields so far produced. Where a metal shield is used, holes will accidentally be burned in it, and if used in that condition it wil be to the detriment of the operator's eyes. Also slight shocks are often felt, when welding with a metal face shield in close places, which will tend to make an operator nervous and may result in a poor weld. This is especially true when the face and hands are moist from perspiration.

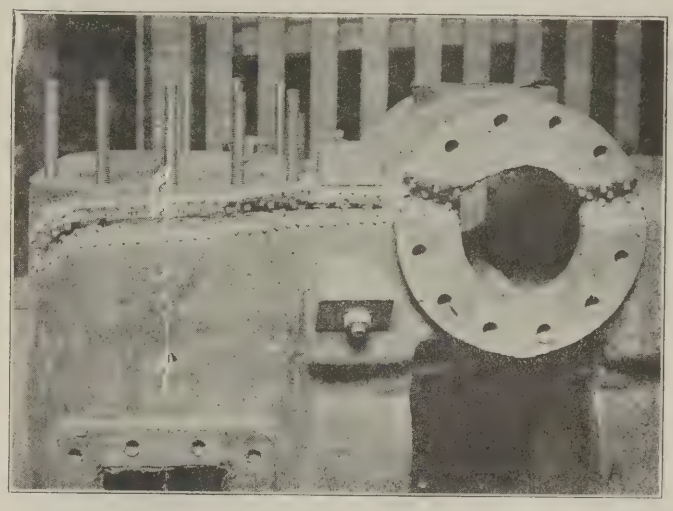


Fig. 5. Broken Cast Iron Feed Water Pump Showing Method of Preparation for Bare Arc Welding

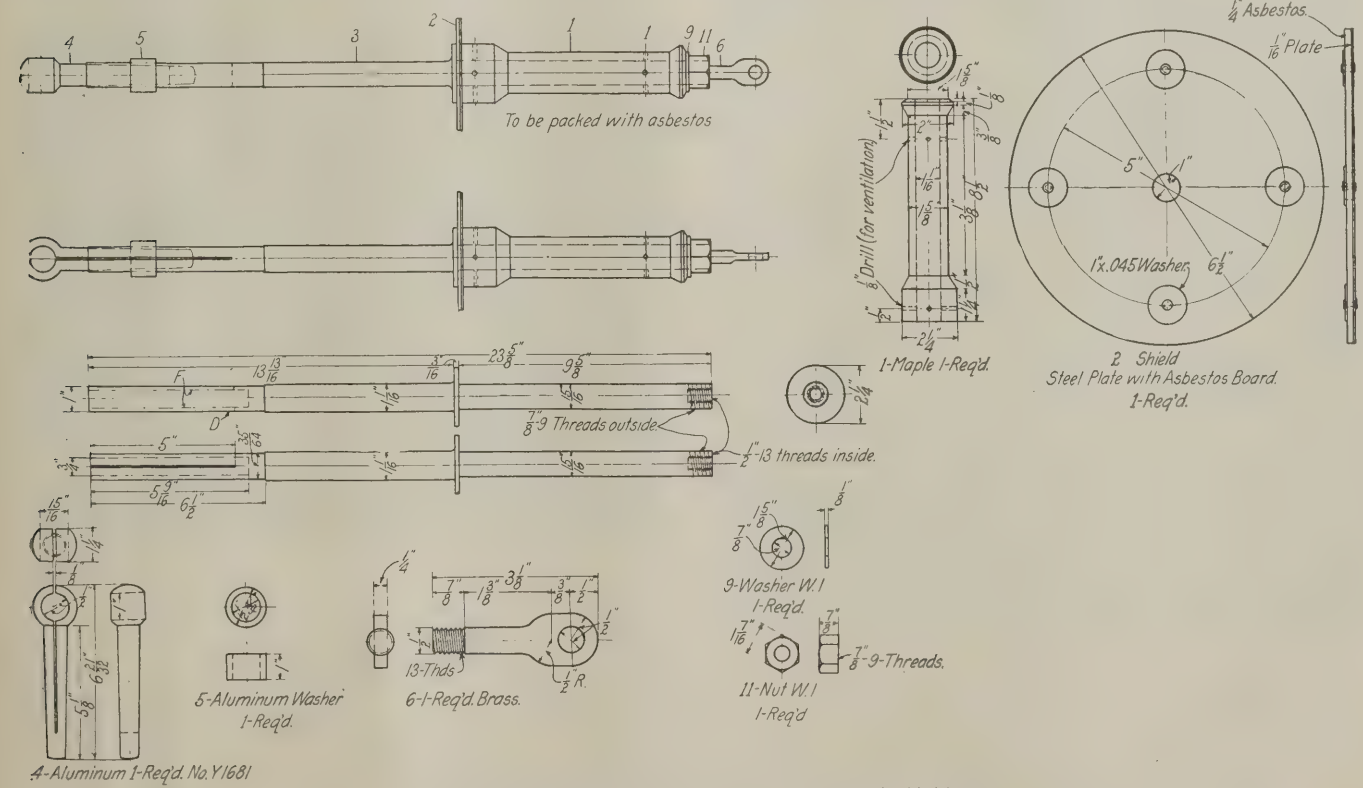


Fig. 4. Construction Details for Carbon Electrode Holder

Substitute for the paragraph, "Helmet Type," the following new paragraph:

Helmet Type.—For the more difficult operations, such for example, as overhead welding or welding which requires an operator to be in a standing position, and carbon arc welding, a shield of the helmet type should be provided in order that the operator may have free use of both hands. Many different designs of head helmets are on the market which are satisfactory. Fig. 2, page 104, 1918 proceedings shows a face shield of the helmet type.

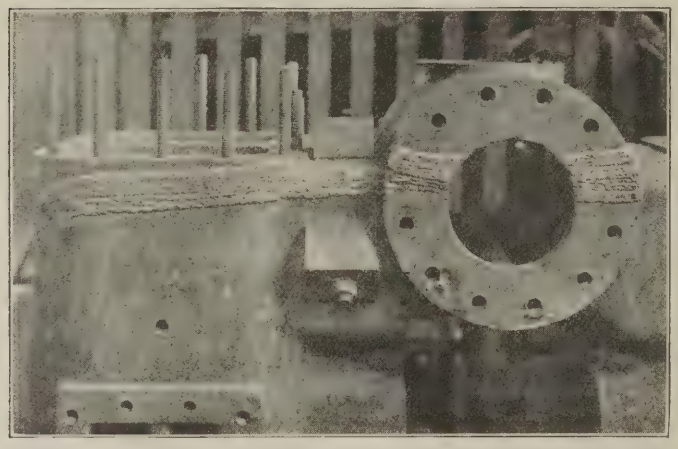


Fig. 6. Broken Cast Iron Feed Water Pump Welded with Bare Electrode

Page 105.—A new paragraph added to the subject, "Glasses,"

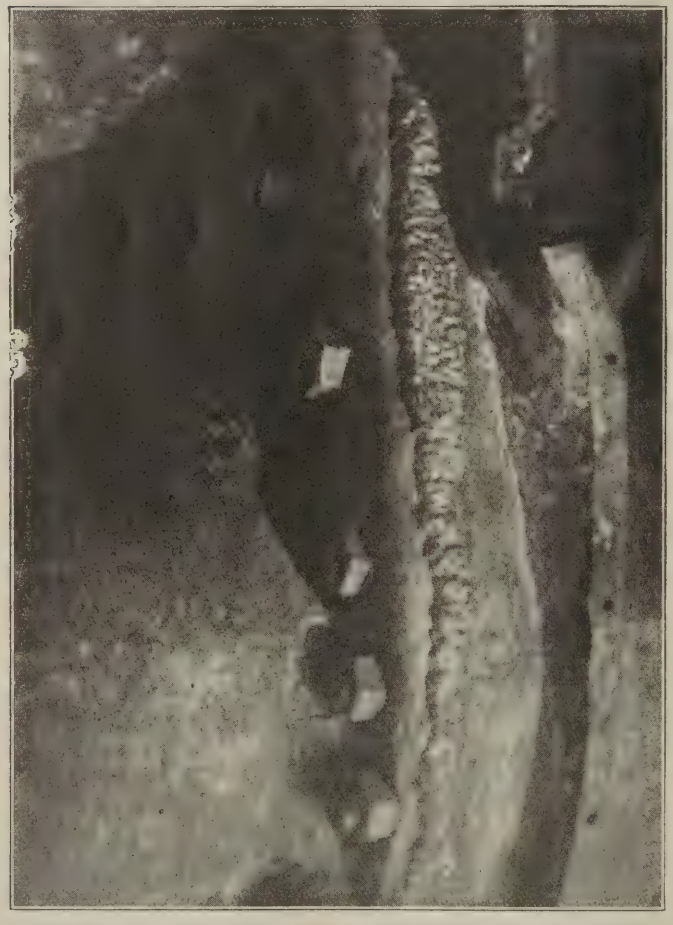


Fig. 7. Locomotive Cylinder Repaired by Arc Welding Process

page 103, immediately following the last paragraph on that subject. The new paragraph to read as follows:

So far as protection to the eyes of the operator is concerned, from data available at the present time, it seems fairly evident that no injury to the operator's eyes will result from either of the colored glass combinations referred to, on the subject of glasses in the 1918 proceedings. So far as is known no cases

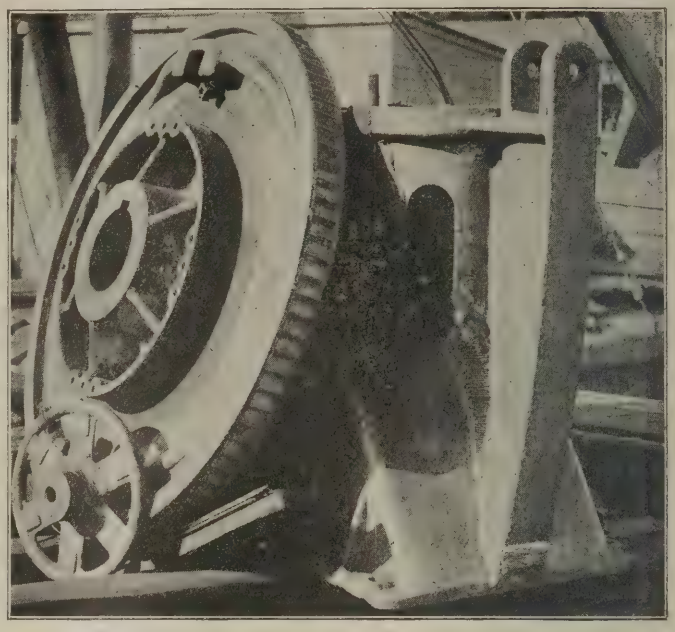


Fig. 8. Damaged Anchor Engine and Wheels of the S. S. Maui Showing Welds

are on record where an operator has had his eye sight permanently impaired using the electric arc welding process and since up until recently all welding was done with the colored glass combinations, it is reasonable to assume that no injury will result in the future from the use of this combination. However, there appears to be a distinct advantage from the use of the new welding glasses which differ from the old colored glasses in that the coloring matter is introduced into the glass in the process of manufacture, permitting a higher degree of visibility of the arc and surrounding metal. In other words the operator using the new welding glasses is able to see the metal in and

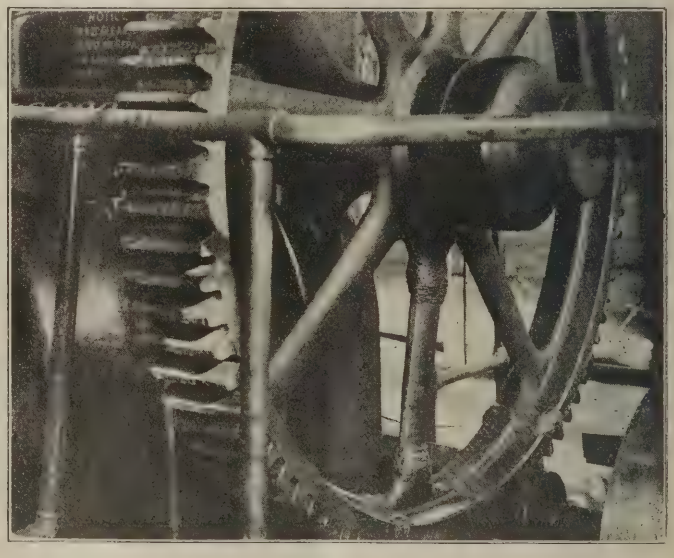


Fig. 9. Cast Iron Gear Repaired by Electric Arc

around the weld better than it is possible for him to see it when using the old colored glass combination. In view of this fact it is natural to assume that it will be possible for an operator to get better average results using the new glass, owing to the fact that he has a more intimate knowledge of what is going on in the weld.

Two new paragraphs added under the new subject heading, "Eye and Body Protection," immediately preceding the subject,

"Portable Screens," page 105. These two new paragraphs pertain to body protection and read as follows:

Body Protection.—In the protection of the hands and arms from the arc rays it is necessary to wear gloves. Canvas gloves, particularly of the gauntlet type will serve for this protection. Ordinary work shirts made of heavy closely woven material will

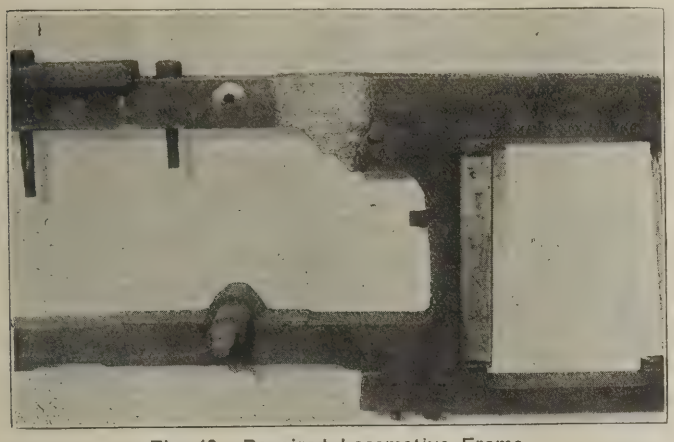


Fig. 10. Repaired Locomotive Frame

give ample protection to the arms. Unless the hand shield or head helmet is so designed as to protect the neck, the shirt should fit closely around the operator's neck. Flying particles of hot metal which accompany electric welding will burn holes in the operator's clothing and to guard against this, canvas or leatheret aprons are usually furnished.

In the event of an operator being burned by a globule of hot metal, such burns should receive immediate attention, as there seems to be a poisoning effect sometimes accompanying such burns, which may be easily avoided if ordinary precautions are taken to wash the wound with any of the ordinary disinfectants furnished.

Equipment Accessories

Paragraph heading inserted ahead of subject "Portable Screens," page 105, to read as follows: "Equipment Accessories."

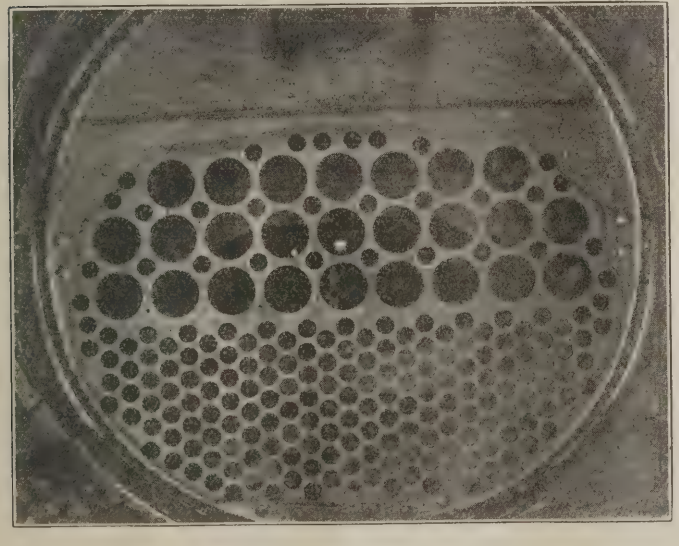


Fig. 11. Broken Front Tube Sheet Welded In

Page 108.—Two paragraphs added to the subject, "Electrode Holders," page 106, immediately preceding the subject, "Ground Clamps," page 108. The new paragraphs to read as follows:

Electrical connection between operator's flexible cable and electrode holder should be made with a clamp rather than by means of solder or patented connector, since otherwise this electrical connection will be the source of continual trouble and delay to the operator. The use of a clamp also permits the making of a fresh connection in a comparatively short time without the use of special tools.

Any electrode holder, whether for carbon arc welding or metallic arc welding, should be as light as is consistent with carrying capacity sufficient to prevent undue heating. Holders of the latest types are shown in Figs. 3 and 4.

Page 109.—A new paragraph added to the subject, "Carbon Blocks and Rods," immediately following the tables on "Rods" and "Blocks." The new paragraph to read as follows:

For some special jobs where the use of carbon or copper molds is impracticable, pulverized carbon held together with a suitable binder might be used to make a paste or putty which can be used in the same manner as molder's sand. It has the advantage, however, of being a good electrical conductor and permits drawing of an arc directly on the mold.

A new paragraph and subject, "Ground Connections," to be

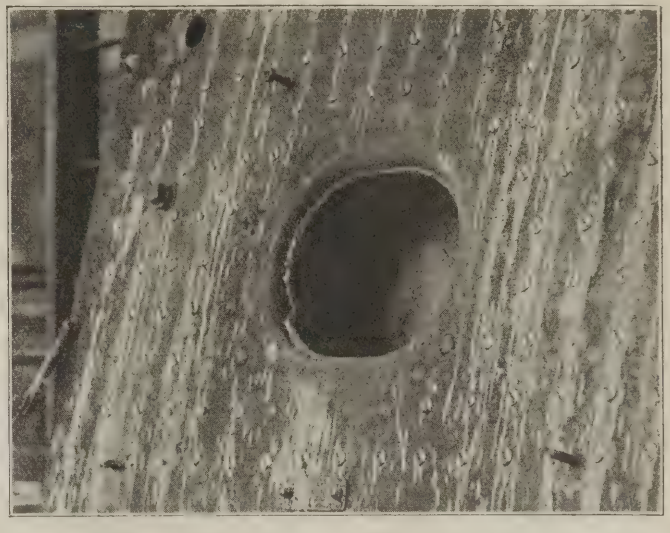


Fig. 12. Electric Welded Fire Door Flange

added immediately preceding "Cable Reels," page 109. The new paragraph to read as follows:

Ground Connection.—On metal electrode welding, wherever possible, and always on carbon electric welding the ground connections should be fastened to the work in such a manner as to permit the arc to be moved away from the ground connection in welding. This practice makes the arc considerably easier to operate, since the magnetic influence exerted by the current passing through the work, tends to help the arc move in the desired direction rather than hinder it.

The paragraph below the table, "Chemical Composition," page 109, should be changed to read as follows:

The composition of the mild steel electrodes commonly used is

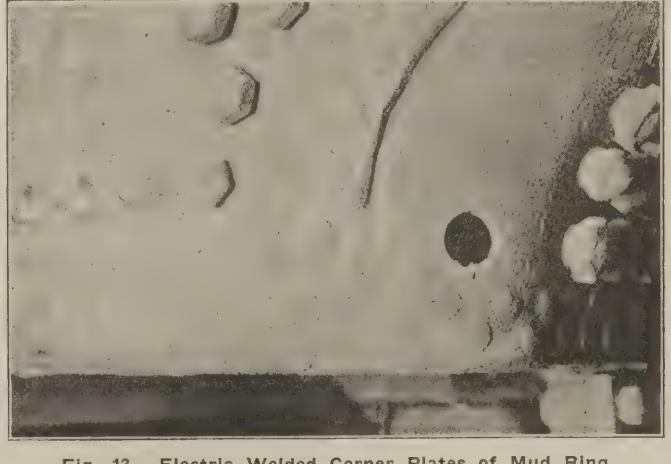


Fig. 13. Electric Welded Corner Plates of Mud Ring

below 0.10 of 1 per cent carbon, and manganese not to exceed 0.50 of 1 per cent, with only a trace of phosphorus and sulphur.

Page 111.—A new paragraph to be added to the subject of "Coated Electrodes."

The use of lightly coated electrodes has developed with great

rapidity during the past year. The one immediate and apparent advantage of a coating on a mild steel wire is that regardless of the variation in the composition of the wire, it will work uniformly well in the arc, if it has a suitable coating on it. The lack of uniformity in welding wire has always been a very serious matter. By the use of a coating, this difficulty is entirely eliminated. Another important advantage of a coating on welding wire is that it provides a scale for the weld, which when the coating has the proper composition has a greater coefficient of contraction in the weld, so that when the weld cools somewhat, the scale may be readily removed by light blows from a hammer, thus exposing perfectly clean metal, preparatory to the next layer of metal to be deposited. No actual data is available to prove that a light coating on welding electrodes will give an appreciable ductility to the metal deposited under shop conditions. There is reason to believe that in the future this desirable result will be accomplished by the use of a slightly coated electrode. It seems certain that in order to use a covered electrode, the coating must be of inappreciable thickness so that the slag formed

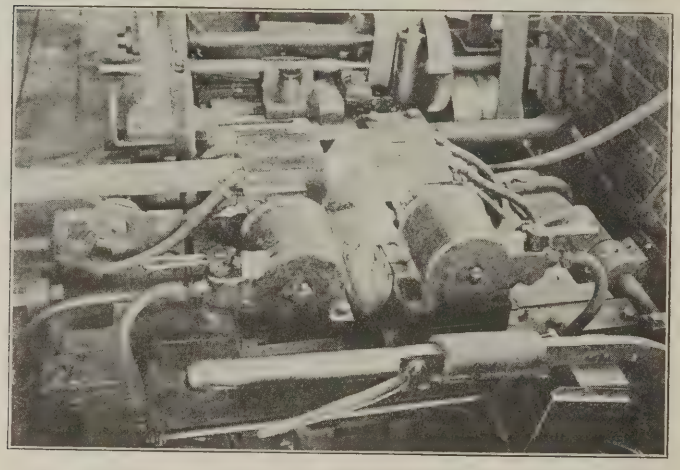


Fig. 14. Electric Welding Machine for Safe Ending Flues

by its fusion will not interfere seriously with the arc or become mixed with the metal which is being deposited in the weld. Neglecting the question of whether or not an appreciable degree of ductility is obtained by the use of a covering of inappreciable thickness, it is the opinion of the committee that the use of the covering can be profitably extended to gain the advantages enumerated above.

A new paragraph and subject, "The Use of Fluxes," to be added immediately preceding the subject, "Instruction Chart, etc." page 111. The new paragraph and subject to read as follows:

The Use of Fluxes

The question of the use of fluxes in arc welding has been mentioned at times, whether there was anything on the market that was beneficial insofar as arc welding was concerned, but so far the committee has been unable to ascertain from any source, where flux has been used to advantage. In some special cases, such as carbon arc welding and also in safe ending of flues and some other special jobs, it is claimed that the flux has been beneficial.

Choice of Men for Operators

Page 132.—Two additional paragraphs added to the subject, "Choice of Men for Operators," page 131, immediately preceding the subject "Instructions for Operators," page 132. The new paragraph to read as follows:

The time required to train an operator for dependable carbon arc welding will be greater than that required for metallic arc welding. In either case much will depend on the individual. Some operators will qualify for repeat operations at the end of 2 or 3 weeks, where others will require more training. For vessel welding or machinery welding, the best results will not be obtained until the operator has had from 6 to 12 months experience. Very few operators will qualify for universal welding and those that have qualified have had not less than 4 years experience.

In order to fix the responsibility for properly training operators, the plan of organization includes a welding instructor. The welding instructor should be located, preferably, at one of the main shops and he should have facilities for training operators thoroughly and completely. The responsibility for furnishing men that are properly trained should be placed upon the welding

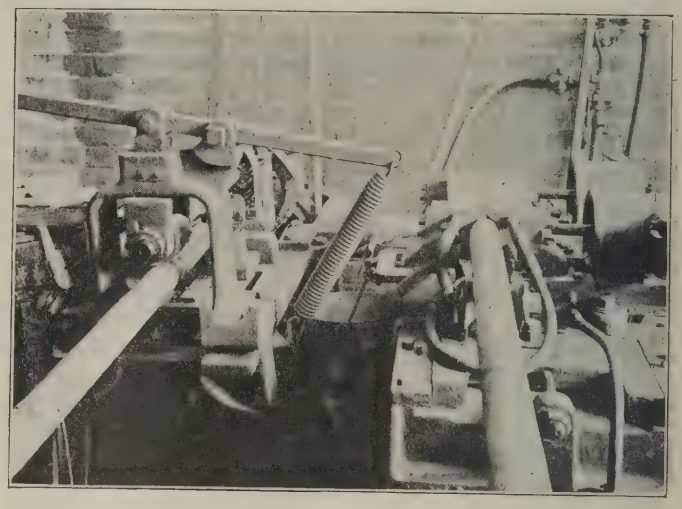


Fig. 15. The Welding Machine and Roller in Operation

instructor. He should be given the authority to rate an operator according to his ability and the class of work with which he can be trusted.

Malleable Castings

Page 140.—Additional paragraphs and illustrations on the preparation of work in connection with the welding of cast iron under the general heading, "Malleable Castings," page 139. These new paragraphs and illustrations to follow immediately after the first paragraph on page 140 and to read as follows:

When pieces of broken cast iron parts cannot be located it is the practice to substitute the missing parts with a forging or cast steel casting. Where such material is used, however, the cast iron side of the weld must be studded. The size and spacing of

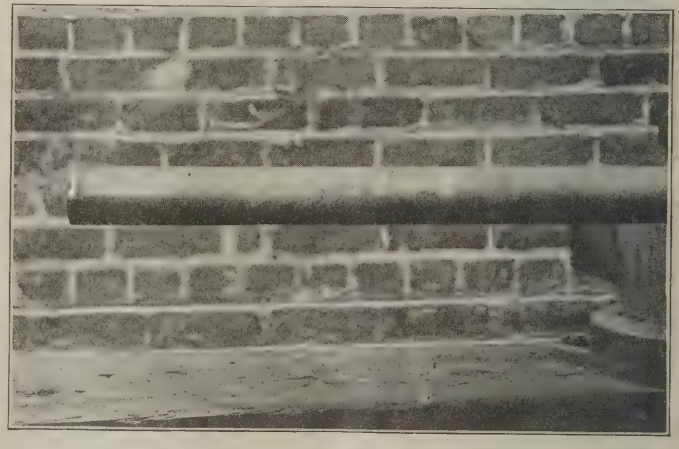


Fig. 16. A Flue Safe Ended by Electric Butt Welding

studs depends upon the thickness of material in the part. The studs in the "V" or edge of weld must be in tensile and and the studs back of the "V" or weld in shear so that the tensile and shearing strength of studs will equal the tensile strength of the original part.

The accompanying illustration, Fig. 5, shows the method of locating studs. For further reference relative to welding cast iron with the electric arc the committee refers to an article on that subject published in the, May, 1918, issue of the *Railway Electrical Engineer*.

Owing to the facts of contraction, it is important that the welding be done with a small electrode approximately ⅛ in. and

with a current density as low as consistent for good welding. The weld should be made in sections, always welding in an upward direction in case of vertical fracture. Each section should be finished at least flush before starting on another section. Accompanying illustrations, Fig. 5 to 9 inclusive, are examples of cast iron welding being done in various industries.

An additional paragraph and subject, "Welding of Frames," to read as follows:

Welding of Frames.—A typical example of electric arc welding of a locomotive frame, which is now the practice on nearly all roads is shown in Fig. 10.

An additional paragraph and subject, "Welding of Fireboxes," to read as follows:

Welding of Fireboxes.—Examples of fire box work being done by the metallic arc welding process are shown in Figs. 11, 12 and 13.

An additional paragraph and subject, "Welding of Flues," to read as follows:

Welding of Flues.—No doubt the most important application in electric welding processes is that of welding tubes in the back flue sheet. This has come to be common practice with many railroads. In some quarters it is yet a question as to the economy to be effected by the welding of tubes. However, on roads which are thoroughly versed in the subject and which have practiced flue welding for a sufficient length of time to enable the operators to become efficient, the opinion is much in favor of the electric arc process. Past experiences show that many locomotives which had welded flues, remained in service without any flue trouble for a period of at least three years. However, in extremely bad water districts they have been known to give serious trouble at the end of six to eight months.

An additional paragraph and subject, "The Safe Ending of Flues by Electric Butt End Welding Process," to read as follows:

The Safe Ending of Flues by Electric Butt End Welding Process.—There are two roads operating in the United States today which use to a certain extent the butt end electric welding process for safe ending locomotive flues. One of these roads uses this method entirely and has been doing so for quite a number of years. As information, your committee submits the following statement concerning the general results obtained by this road, together with a resume of advantages obtained by the use of this machine over the oil furnace or other welding processes now in use.

The illustrations, Figs. 14 to 16 inclusive, show the machine in operation and the finished flue.

Total number locomotives	998
Number of flue welding machines	3

These three machines take care of all safe-end welding for the entire above locomotive equipment.

Number of flues welded by one machine during the year 1918	152,000
Approximate estimate of energy necessary per flue welded	200 watt hours

Transformer capacity necessary for machine 30 k. w. single phase:

Approximate rate of welding flues	80 per hour
Size of flue welder	Max. 2½ in. diameter
Minimum	2 in. diameter

Number of men necessary to handle machine:

One welder; one helper; one laborer.

Advantage of Electric Welding Safe Ends on Flues

(1) 50 per cent reduction in the cost of welding.

(2) Strength of weld 90 per cent of original metal.

(3) One-third floor space required as compared with open fire methods.

(4) Weld so uniform that water test not necessary before flues are put in the boiler.

(5) Marked reduction in flue failures on the road.

Committee.—H. C. Meloy (Supervisor of electrical appliances, N. Y. C. Lines West), chairman; H. R. Pennington (assistant electrical engineer, C. R. I. & P.); E. C. A. Geister (chief electrician, G. R. & I.); A. H. Geald (Pullman Co.); W. A. Stockbridge (electrical engineer, Pennsylvania Lines West).

Discussion

The report of the Committee on Electric Arc Welding was read by H. C. Meloy, of the New York Central Lines, who stated that the committee was unable to secure information as to whether or not any manufacturer of steel cars was using the electric arc process to replace rivets in the construction of new cars. He did say, however, that he had learned that some street car companies had purchased welding outfits and were eliminating rivets by using the arc welding process. Mr. Meloy said he would be glad to hear from some of the other members regarding the advisability of having some one directly in charge of the welding on the railroads. Many are doing welding but are only hitting the high spots and he felt that there was a large amount of second hand material that could be reclaimed.

In answer to Mr. Meloy, Mr. Wanamaker made it very plain that some one who had made a thorough study of the arc welding process should be in charge of such work. He said no man could know anything about welding unless he gave time to the study of the metallurgical and mechanical side of it as well as to the electrical side. If arc welding became universal in its application, as he believed it would, then by all means a welding supervisor was necessary. Such a man must know the art or it will be a failure. Mr. Wanamaker humorously criticized the use of the word "inappreciable" used by the committee as applied to the coating of electrodes, stating that presumably what was meant was a very thin coating. He said by using coated electrodes it was possible to avoid brittleness in the weld and secure a metal that was very tough. Brittleness, he said, always occurs in welds made with bare wire. As a particular instance of the value of coated electrodes he cited the repair of couplers which had been very extensively and successfully accomplished on the Rock Island Lines. Another advantage of the coated electrode was the fact that various alloys could be introduced into the welding wire which help to give much better metal in the weld than could ordinarily be obtained with mild steel.

Mr. Billau stated that while his road did not have a welding supervisor he felt that the success they had had with welding was due to the local supervision given to the work in the various shops. New welders were carefully instructed, he said, and new applications which were found successful were extended to other shops. He said he would like to hear from some of the members on the subject of eye protecting glasses.

In reply, Mr. Meloy stated that two or three of the glass manufacturers were turning out glasses of a single thickness but of different densities. Not every welder desires the same density of glass. The manufacturers, he said, are grading the glasses so that the welder may choose the glass which has a density best suited to his eyes.

Mr. Pennington said that they had adopted a special kind of glass, one grade of which, known as No. 12, was being largely used.

With reference to the electric welding of flues, Mr. Quinn said the Norfolk & Western had begun this work in 1912. One machine had been brought and tried and later another was added. He said that perfect success had attended the work from the beginning. Not only the safe ending of flues was accomplished but the superheating tubes were also welded with perfect success.

Mr. Marshall wanted to know what the relation in speed was between welding electrically and with the old open fire method. In reply to this Mr. Quinn stated that the original rate of welding flues by the open fire was from twenty to twenty-five tubes per hour. He admitted that the work could be done quicker now but contended that

the quality of work was not as good. With electric process he said it was possible for welders working on piece work to make as many as eighty welds per hour, the average weld requiring from twenty-five to thirty seconds.

Mr. Billau raised the question of spot welding to which Mr. Godard of the Illinois Central replied that he was using a spot welding machine and had found that the average speed was fifty per cent faster than riveting and in some cases as high as sixty-five or seventy per cent higher. He stated that the machine was entirely automatic and that once the proper timing was obtained this could be recorded and the machine always set for this.

Mr. Murray of the Electric Arc Cutting & Welding Company wanted to know why the committee recommended working with a long arc.

Mr. Meloy stated that they had tried alternating current welders giving a short arc and had not been able to obtain satisfactory results on account of the operators being more or less nervous. The welders looked upon the machine as being unsafe due to numerous shocks received from it. He said that there were probably operators who could do good work with the alternating current machine, but that he had found that he could not get the results he could from a direct current outfit.

Mr. Quinn explained the matter in this way. He said he had given one of his best welding operators a direct current and an alternating current machine. After about a month he asked the operator how he made out with the alternating current outfit. The operator replied that both machines did good work but that for some kinds of work he preferred the direct current machine, showing that the class of work evidently was a determining factor in his choice of machine.

Mr. Billau stated that they had only done some experimental work with the alternating current welders on the Baltimore & Ohio, but that on the Western Maryland, which was controlled by the Baltimore & Ohio, he had heard they were getting satisfactory results with the alternating current equipment.

Specifications for Electric Train Lighting Equipment

Variety of Practices Now in Vogue Can Be Greatly Reduced Without Impairing Quality of Service

Your committee has devoted its efforts this year to a further study of the subject of a general specification for axle generator equipment. The problem is a difficult one and, while progress is being made, it is necessarily rather slow. There are not only several axle generator train lighting systems differing more or less fundamentally, successfully operating on American railroads, but the views of various car lighting engineers with respect to requirements to be met, as expressed in axle generator specifications issued by several railroads, vary widely. While it is recognized that it is impracticable as well as undesirable in a general specification of this character to cover train lighting equipment in too minute detail, there are many features in which it will be to the mutual advantage of the users and manufacturers to get together.

A joint meeting in connection with this subject was held with the Train Lighting Committee of the American Railroad Association and the various axle generator manufacturers While agreements have been reached on a number of items, there are, however, important features which require further study before they can be settled. At this time, therefore, your committee can submit only a progress report of results thus far accomplished and questions to receive further consideration. The purpose of presenting these in detail to the association is to secure as wide a discussion on the subject as possible, which will be of assistance to the committee in completing its work. It is expected that a complete draft of the proposed specification can be presented at the June meeting.

The features that have been considered are grouped in the following between those that have been at least tentatively agreed upon and those to receive further study. In this report no effort has been made to arrange the subjects in the order or use the wording in which they will appear in the completed specification.

Subjects in Which at Least Tentative Agreements Have Been Reached

(1). *Material for Armature Shafts.*—A good deal of trouble has been experienced due to armature shafts bending, which has been overcome by the use of better quality steel. It was, therefore, felt advisable that the physical characteristics of the steel used in the shafts should be specified, in which connection the following characteristics were agreed upon:

Tensile strength lb. per sq. in.	90,000
Elastic limit lb. per sq. in.	60,000
Reduction in area per cent.	45
Elongation in 2 in. per cent.	18

(2). *Bearings.*—In the 1918 report the association agreed upon certain sizes of ball bearings. It has been recommended that these be changed for controlled speed type of generators from that shown in the previous report. See Table I.

(3). *Grease Retainers.*—More or less trouble has been experienced with oil and grease from the bearings working over into the generator frame. To overcome this it has been recommended that grooves be machined in the end housings and felt washers, fitting the shaft snugly, be applied to the inner side of the commutator end housing and to both sides of the pulley end housing.

(4). *Air Gap.*—No change in the minimum size of the air gap is recommended, the proposed wording to be: The mechanical clearance in the air gap shall be such that an oval shim ½ in. wide and 0.05 in. thick can be passed between the armature and pole faces at all points.

(5). *Pulley Fits.*—No changes in armature pulley fits illustrated on pages 85, 86 and 88 of the 1918 proceedings are recommended.

(6). *Maximum Speed.*—As generators must be designed to operate safely and satisfactorily, both electrically and mechanically at maximum train speeds, this limit should be specified, in which connection 75 miles per hour has been agreed upon as representing the maximum speed allowed on most railroads.

The generator shall be safe to operate both mechanically and electrically at a r. p. m. equivalent to the train speed of 75 miles per hour with a 33 in. diameter car wheel.

(7). *Standard Method of Rating.*—There was submitted at the June meeting a proposed standard method of electrical rating for axle generators, which was also presented to the American Railroad Association, and has been agreed upon by the axle generator manufacturers, which is as follows:

TABLE I

FREE SPEED GENERATORS						CONTROLLED SPEED GENERATORS	
Truck Suspension	BODY SUSPENSION						
	Width of Belt Required to Transmit Necessary Power						
	5-Inch		4-Inch		3-Inch	4-Inch	
Both Ends	Pulley	Comm.	Pulley	Comm.	Both Ends	Pulley	Comm.
412	412	*412†409	409	*409†407	407	312	308

*Preferred. †Alternate.

(1). That the method of testing to determine the rating of an axle generator be as follows:

a. That the generator, together with the generator and lamp regulator, if used, shall be connected in a normal manner, to dead load resistance in the battery and lamp circuit, and

b. Shall be operated continuously for five hours, with commutator hand hole covers removed, at the minimum r. p. m. that will generate rated volts, at the load side of the generator regulator and carry the current, and that

c. The net current output shall be the armature current less all current consumed in the generator fields, generator regulator, and lamp regulator, if used.

(2). That the rating of an axle generator be based upon the following:

a. The rating of an axle generator, when connected and operated as above, shall be the maximum net current that the generator will carry without exceeding the values shown in Table II.

(3). That the rating test shall be made at or above 15 degrees C. ambient temperature.

(4). That a badge plate be securely attached to each axle generator which shall show the following:

a. Manufacturer's name.

b. Type number.

c. Nominal voltage of generator (40 volts for 30-volt system and 80 volts for 60-volt system).

d. Rating in amperes as above determined.

e. Minimum speed in r. p. m. at which generator will deliver rated volts and amperes.

While there may be some confusion during transmission period in adopting this method of rating as compared to the various methods of rating now employed by the different manufacturers, it is felt that the new method should be put into effect as quickly as possible, and the railroads are urged to make use of this rating in specifying or ordering axle generator equipment. This does not prevent any one who may so desire from specifying more severe restrictions in their own specifications, the effect of which would be to decrease the allowable maximum rating of the generator for their own conditions. This should not, however, prevent the generator from being designated by the standard rating, which, while it is an arbitrary one, has the all important advantage that it will place all manufacturers on the same basis as far as the electrical capacity of their equipment is concerned.

TABLE II

	Maximum Observable Temperature	Maximum Observable Rise in Temperature
Any part of generator or regulators except commutator, brushes, brush rigging and bare copper solenoids	110 deg. C.	70 deg. C.
Commutator, brushes, brush rigging and bare copper solenoids	130 deg. C.	90 deg. C.

Subjects to Receive Further Study

(1). *Armature Pulleys.*—The conclusion was reached that, taking into consideration all factors, cast iron is the most suitable material at the present time for armature pulleys. The committee recommends, therefore, the preparation of drawings covering in detail dimensions of pulleys for ball bearing generators, both those for use with shafts of 1⅝ in. in diameter and larger and for use with shafts less than 1½ in. in diameter. The designs that have been adopted by the association cover primarily only dimensions essential for interchangeability. As a consequence most railroads are still using pulleys of different designs for the various makes of axle lighting equipment. There is no reason today why for any given diameter the same pulley should not be used with all makes and sizes of free speed axle generators for either truck or body suspension, having a shaft 1⅝ in. in diameter or larger. Equipment using shaft 1½ in. in diameter is very limited, the largest number in service being on controlled speed generators. The standardization of the design of this pulley is, therefore, a comparatively easy matter, and is now being worked out by the committee with the axle light manufacturers. It was found impossible to complete this in time to include it in the report. Your committee believes that there is no detail of axle generator equipment subject to periodic renewals that would be of more advantage to the railroads to have completely standardized than the armature pulley.

(2). *Mounting of Ball Bearings.*—The question of specifying the manner in which ball bearings should be mounted has received consideration, but all manufacturers are not in agreement with respect to the details. The following has been suggested by the committee:

As the greater stress occurs in the bearing at the pulley end, while the greater differences of temperature occur at the commutator end, it is good practice to make the commutator end bearing the fixed bearing. To do this, it is customary to lock the outer race of the commutator end bearing between the field frame and end housings and to secure the inner race on the armature shaft. The inner race of the pulley bearing is generally mounted on the armature shaft with a pressure of approximately 500 pounds and the outer race is a sucking fit as regards diameter, but is free to move longitudinally a distance greater than the expansion of the shaft will render necessary.

(3). *Sizes and Minimum Full Load Speed.*—The determination of the number of sizes of axle generators required to meet American railroad conditions is a somewhat complex one and on which it will be difficult to reach an agreement. The size of the lighting load and battery used, percentage of time during which current is supplied from the battery, kind of car, character of lighting and nature of run are all features affecting the problem. The solution is a compromise, and taking into consideration first cost, maintenance, repair parts to be carried in stock, etc., your committee feels that two sizes are sufficient to meet American railroad conditions satisfactorily and economically. However, as there are many railroads which would not have the extreme conditions to be met with, in a general specification of this character it is desirable to cover a larger number of sizes. By use of two or three sizes of frames, two or three types of armatures a number of sizes of equipment with various minimum full load output speeds can be provided. Study is being made by the various axle generator manufacturers with a view to determining the minimum number of combinations that would be desirable, in which connection the committee has suggested the following as a tentative working basis:

TABLE III

CLASS OF SERVICE	Capacity Generator in Amperes	Minimum Full Load Output Speed Miles Per Hour
Official, Pullman and dining cars having heavy lighting loads or severe operating conditions	100	26
Mail, dining cars, etc., where loads are not so heavy and operating conditions less severe	75	26
Coaches, passenger baggage, baggage cars, etc., with loads not exceeding 600 watts, and under average operating conditions	50	21
Similar classes of cars that are operating in slow speed branch line and suburban service	50	16

The minimum speed at which full load output is available is of great importance and in the past has not received the consideration that it should, with a consequence that much of the lighting equipment now in use is unsuitable for cars when placed in slow speed branch line service. As weight, physical dimensions, belt tension, etc., increase to a greater or less degree with the decrease in minimum full load output speed, a careful and detailed study of this subject is necessary in determining specification limits.

(4). *Cutting In Speed.*—Cutting in speed is of much less importance than the minimum full load output speed. It will be designated to be within certain percentage limits of the minimum full load speed.

(5). *Regulating Equipment.*—Standardization of location of supporting bolts is highly important and is being taken into con-

sideration. Study is also being made to determine reasonable operating limits for various functions of regulating apparatus.

Minimum Inside Height for Storage Battery Compartments

In addition to the subject of specification for axle generating equipment, there has been referred to the committee for consideration the question of increasing the present recommended minimum inside height for storage battery compartments, which is 21½ in. There has been considerable complaint that the present minimum height is such that it considerably interferes with readily inspecting and flushing batteries, particularly where batteries are assembled in more than two cell trays. Your committee recommends this dimension be increased to a minimum of 23 in.

It is expected that further meetings will be held with manuturers early in December. In addition to verbal discussion of this subject, your committee would be very glad to receive written discussion covering suggestions and other comments members of the association may have to offer, in time to have available for use at this meeting.

Committee: L. S. Billau (assistant electrical engineer, B. & O.), chairman; Ernest Lunn (chief electrician Pullman Co.); J. R. Sloan (electrical engineer, Car Ltg., Pennsylvania R. R.); F. J. Hill (chief electrician, M. C.); E. W. Jansen (electrical engineer, I. C.); C. H. Quinn (chief electrical engineer, N. & W.); E. Wanamaker (electrical engineer, C. R. I. & P.).

Discussion

Mr. Billau, chairman of the Committee on Train Lighting Equipment and Practice, did not read the entire report but gave an outline of the most important features of it. He stated that in general the report was in the nature of a progress report pertaining to axle generator lighting equipment for train lighting service. The subject, he said, was a complicated one and that progress had been necessarily slow. There are today a variety of systems differing in construction and design, all of which are giving satisfactory results. Specifications, therefore, must be somewhat general covering all such equipments as give satisfactory operation and also dealing with future of the art. Many of the details have been handled in the past by the association. Specifications for generators should cover the minimum number of sizes that can be successfully handled on American systems tending to reduce the number of equipments to meet same operating conditions and also prescribing certain limitations. The purpose of the progress report, Mr. Billau stated, was to secure from car lighting engineers, opinions that would act as a guide during the coming years. The committee hoped that when the final report was presented it would be able to offer not something that was of interest from an academic viewpoint but something that would become a real live and useful specification. Mr. Billau said that the committee could draw up specifications that would meet American railroad conditions. Details concerning ball bearings, grease, pulley faces and air gap had been passed upon at previous conventions but the committee felt that the question of operation had never been as carefully considered as it should be, particularly with reference to speed limitations. Mr. Billau then read section (7) on Standard Method of Rating. He said the question of rating had always been more or less confusing from the fact that one road would call a machine a fifty-ampere generator which another road would designate as a seventy-five-ampere machine. He thought that the time had arrived when the committee should lay down specifications concerning the design of the generator pulleys so that such design might be known as standard. In this connection one of the chief difficulties to be met is the question of pulley ratios. Another question that should be decided was the matter of sizes—how many sizes of machines should be used. Among other things which the committee felt should be considered was the inside height of battery boxes. It was believed that the present height could well be increased to twenty-three inches.

The discussion which followed Mr. Billau's remarks was confined very closely to the question of generator speeds and the number of sizes of machines which would cover all of the requirements of American railroads. In connection with this question of various speeds for different kinds of service it was voted to include Table 3 of this report in the final specification covering this point.

The matter of ampere rating raised some discussion also. Mr. McGary of the New York Central Lines stated he felt that fifty-ampere machines were ample for the service. He said that when the demand for light became greater that they increased the size of their storage battery to take care of the increased load.

The question of the height of pulley flanges came up and according to the statement of Mr. Bliss there is no limit to the height of flanges on generator pulleys but there was a limit to the flanges on axle pulleys. Mr. McGary was asked to tell something of the tests that had been conducted on the New York Central Lines with reference to belts and pulley flanges. Mr. McGary told in some detail of the manner in which they had watched belts of various sizes under operation. The conclusions reached from these observations indicated that a high flange on the generator pulley was unnecessary and that the belt passing over the axle pulley did not climb the flange as much as had been expected.

Mr. Bliss remarked that it was unfortunate that motion pictures had not been made of the tests so that the committee could have seen these actual conditions.

F. J. Fischer of the *Railway Electrical Engineer* stated that at the time the tests were made he was employed on the New York Central and had taken part in making these tests. Data and information concerning them had been compiled as well as photographs taken all of which he was sure could be placed at the committee's disposal.

Mr. Sloan recommended that some tests be made on flanges of various heights before the next convention.

The report was received and the committee continued.

Should Association Join the A. R. A.

Immediately after the discussion of the report of subcommittee "B" closed, Mr. Sloan put before the association the question of its becoming a part of the American Railroad Association. There was considerable discussion as to whether the association should join the American Railroad Association as a new section of that body or as a division of the mechanical section. The matter was finally left to the executive committee for their further consideration.

Election of Officers

The Friday morning session which lasted well into the afternoon was concluded by the election of officers. The following officers were elected: President, L. S. Billau, assistant electrical engineer, Baltimore & Ohio, Baltimore, Md.; senior vice president, L. C. Hensel, chief electrician, St. Louis-San Francisco, Springfield, Mo.; junior vice president, E. S. M. Macnab, electrical engineer car lighting, Canadian Pacific, Toronto, Canada; secretary and treasurer, Jos. A. Andreucetti, assistant electrical engineer, Chicago & North Western, Chicago. Executive committee, L. C. Moore, electrical engineer, Missouri Pacific, St. Louis, Mo.; J. R. Sloan, electrical engineer train lighting, Pennsylvania Lines East, Altoona, Pa.; A. E. Voigt, car lighting engineer, Atcheson, Topeka & Santa Fe, Topeka, Kan.; C. H. Quinn, electrical engineer, Norfolk & Western, Roanoke,

Va.; E. Lunn, chief electrician, Pullman Car Lines, Chicago; F. J. Hill, chief electrician, Michigan Central, Detroit, Mich.

Entertainment

Entertainment features were provided. Informal dances were held on the first three evenings of the convention at the Hotel Morrison. On Wednesday afternoon a theater party was arranged for the ladies in attendance. A dinner was given Friday evening under the auspices of the Railway Electrical Supply Manufacturers' Association, followed by a dance at the Hotel Congress.

Railway Electrical Supply Manufacturer's Exhibit

The Interest of Railroad Men Aroused By An Excellent Display of New and Improved Equipment

THE Railway Electrical Supply Manufacturers' Association which had charge of the exhibit and the social functions at the eleventh annual convention of the Association of Railway Electrical Engineers at Hotel Morrison, Chicago, October 28 to 31 inclusive, can well lay claim to a remarkable and most successful convention in arranging for the largest and most complete exhibit and program of entertainment that has ever been prepared in connection with this event.

The officers of the executive and arrangement committees are to be congratulated upon the results of their work. The businesslike manner in which the exhibits were displayed and demonstrated to inquiring parties had much to do with the enthusiastic interest on the part of every railroad man in attendance at the convention.

Although the membership of the Railway Electrical Supply Manufacturers' Association is comparatively small (consisting of 42 companies with approximately 135 members) the enthusiasm and willingness to serve is tremendous. Out of the 42 companies who are members of this association there were 33 companies who maintained booths and exhibited devices used by the railroads in the electrical and mechanical departments. In most every case the supply manufacturers, through the process of elimination have arrived at the point of exhibiting only those devices and appliances which are of the greatest interest to the railroad men who usually attend such conventions. Some of the companies exhibited, for the first time, appliances for use in the railroad electrical field.

If one is to judge by the interest displayed at this convention there is every reason to believe that future meetings will be supported in the same spirit and enthusiasm, with the same businesslike characteristics as prevailed at this meeting.

Election of Officers

Promptly at five o'clock on Thursday afternoon, October 30, the Railway Electrical Supply Manufacturers' Association held its annual meeting for the election of officers for the ensuing year. The officers elected are as follows: President, J. H. Rodger, Safety Car Heating & Lighting Company, Chicago; senior vice president, F. V. McGinness, Transportation Engineering Corporation, New York; junior vice president, D. Woodhead, Central Electric Company, Chicago; secretary, J. Scribner, General Electric Company, Chicago; treasurer, Edward Wray, Sangmo Electric Company, Springfield, Ill. Executive Committee: E. C. Wilson, U. S. Light & Heat Corporation, Chicago; G. H. Atkin, Electric Storage Battery Company, Chicago; B. G. Durham, A. & J. M. Anderson Company, Chicago; H. C Varney, Schroeder Electric Headlight Company, Chicago; F. F. Skeel, Crouse Hinds Company, Chicago; George R. Berger, Gould Coupler Company, Chicago; J. E. Kilker, Pyle-National Company, Chicago, and Otis B. Duncan, George Cutter Company, Chicago.

Companies Exhibiting

The 33 companies maintaining booths and exhibiting their devices are as follows:

Albert & J. M. Anderson Manufacturing Company, Boston, Mass.—Complete line of charging plugs and receptacles for yard charging plants and car equipment. Line of plugs and receptacles for arc welding purposes, both for direct current and alternating current circuits, including double, triple and four-pole type with various forms and mountings. Line of plugs and receptacles for locomotive headlight work. Various watertight special type, single, double and triple-pole plugs and receptacles for light and power work on docks and similar places. Represented by B. G. Durham, Chicago.

Benjamin Electric Manufacturing Company, Chicago.—Exhibited a line of headlight sockets, water tight attachment plugs, watertight lighting fixtures, porcelain enamel steel reflector for industrial illumination. Various styles of lighting panels and a pole line of marine fittings for railway and steamship use. Represented by O. L. Johnson, W. J. Goodrich and E. A. Detrick of Chicago.

Bryant Electric Company, Bridgeport, Conn.—This company displayed a Bryant hospital signal station operating on 110-volts or on 220-volts. A complete line of socket receptacles, plugs, cartridge cutouts and interconnecting blocks. Watertight and non-watertight plugs and receptacles. Panel switches with connections for plug fuses and cartridge fuses. Plug cutouts, conduit fittings, and a new line of threaded cap sockets. Represented by W. O. Dahlstrom, Ward Thomas, and V. B. Habryl of Chicago.

Central Electric Company, Chicago.—Line of "Ralco" plugs and receptacles for battery charging and power service for use in shops, yards, power stations, locomotive and car wiring. "Okinite" wires and cables; "Okinite" and "Manson" tape. "Maxolite" reflectors and sockets.

Four-in-One light fixtures for station and office lighting. D & W renewable fuses. Deltabeston wire for armature winding, heater cords and asbestos covered products. Hand lamps manufactured by Grether Fire Equipment Company, equipped with Edison Storage Battery. Flexible hose armor ⅜ in. to ½ in. for locomotive and car wiring. Represented by Dan Woodhead, J. M. Lorenz, R. N. Baker, A. L. McNeil, W. A. Ross, and A. L. Arenberg, of Chicago. Okinite representatives, John Phillips and W. Hackett, of New York.

Chicago Fuse Manufacturing Company, Chicago.—Displayed its line of enclosed fuses, all types and sizes, refillable and non-refillable. Aso outlet and gear box line. Represented by H. P. Collins and T. C. Walsh of Chicago.

Crouse-Hinds Company, Syracuse, N. Y.—This company exhibited a complete line of imperial flood lighting projectors. Condulets for all purposes, plugs and receptacles for arc welding and power service. Complete line of locomotive wiring condulets for electric headlight service. Also lamp guards, and safety switches. Represented by F. E. Skeel, E. C. Otto, and Charles Dubsky of Chicago; E. G. Smith, K. W. Mackall, A. F. Hills, W. L. Hinds and C. H. Bissell of Syracuse, N. Y.; J. B. Wilmott, St. Louis, Mo.; A. B. McChesney, Detroit, Mich.

Cutter Company, George, South Bend, Ind.—Exhibited line of yard lighting and shop lighting reflectors also flood lights. A new cutout hanger. Panel Board—safety type and new vapor proof reflector units. Represented by Ottis B. Duncan and S. L. Carl, of Chicago.

Dodge Sales & Engineering Company, Oneida, N. Y.—Displayed its "Keystone" car lighting axle pulley and "Oneida" corrugated bushings. Represented by N. G. Stark.

Edison Storage Battery Company, Orange, N. J.—This company exhibited Edison nickel iron car lighting batteries. A portion of the cells exhibited were cut away to show all of the structural details. Represented by W. H. Bower and H. J. Butler of Chicago, and E. M. Cutting, Orange, N. J.

Electric Dynamic Company, Bayonne, N. J.—This company displayed a 3½-h.p. direct current, inter-pole motor and a 10-h.p. ball-bearing induction motor both for industrial purposes. Also rotors complete for 3 and 25-h.p. motors with ball-bearings, and a 7½-h.p. compensator complete for either two or three-phase circuit with overload and underload relays and transformers. Beside the line of motors and accessories exhibited this company displayed a 2-kw., ball-bearing F axle light generator complete as installed on cars. A 2-kw. type L-3 axle light generator panel with ampere hour meter control and a type L-12 motor-driven lamp regulator. Represented by D. W. Balderstan, Bayonne, N. J., and E. A. Barth, Chicago.

Electric Service Supply Company, Philadelphia, Pa.—This company exhibited its Golden Glow and Keystone locomotive headlight equipment. The exhibit consisted of the following: Type L, B, C-1412 one-piece cast iron headlight case with 14-in. Golden Glow mirror reflector, new type L, B, N, C-1412 steel headlight case with number boxes on the side equipped with Golden Glow adapter unit. This adapter unit fits in standard 18-in. by 9-in. case and is equipped with 14-in. Golden Glow glass mirror reflector. Type F. L. 1412 headlight case with Golden Glow mirror reflector and 500-watt concentrated filament lamp. Type F. L.-1419 headlight case with Golden Glow mirror reflector and 1000-watt mazda standard C lamp. Type M, L, C-96 cast iron headlight case used for yard locomotive service with 9-in. Golden Glow mirror reflector. Type L, B, N, V-1412 steel headlight case with number boxes on top equipped with 14-in. Golden Glow mirror reflector. U. S. standard headlight case equipped with Golden Glow adapter unit with 14-in. Golden Glow mirror reflector. Type L, B-1412 steel headlight case with 14-in. Golden Glow mirror reflector. In addition this company showed a display of Golden Glow reflectors to illustrate the process of manufacture from the glass to the completed product. This display included reflectors from 5 in. to 14 in. inclusive. A Keystone Turbo-Generator type 532—500-watt, 32 volts, and Keystone locomotive headlight switches of different types for all ordinary operating conditions. Represented by C. J. Mayer, A. H. Englund, J. R. McFarlin, L. A. Darling, R. S. Lewis and Paul Campbell, of Philadelphia; J. W. Porter, Max A. Berg and L. J. Kirby, of Chicago.

Electric Arc Cutting & Welding Company, Newark, N. J.—This company exhibited a portable alternating current electric arc welding machine for welding metals, also a number of samples of different types of welds. Represented by W. J. Murray, Newark, N. J., and P. W. Wendt, Chicago.

Electric Storage Battery Company, Philadelphia, Pa.—This company's display included the following: A set of Manchester positive plates which had been in operation for seven years during which time they had been in service for over 1,215,000 miles. Also car lighting batteries assembled in giant rubber jars with double flange alloy cover. A standard truck type axle generator, also the body hung generator; the latter was provided with the new belt tension adjusting device of the lever type. Represented by J. L. Woodbridge, Thomas L. Mount and H. E. Hunt, of Philadelphia; G. H. Atkin, O. R. Shortall and H. M. Beck, of Chicago.

Fairbanks, Morse & Company, Chicago.—Exhibited type H sectionalized ball bearing squirrel cage alternating current induction motor; rotor cages with cast-on-end rings and type D. C. starter for squirrel cage motors with oil-immersed switch mechanism and transformers. A sectionalized starter wheel for Fairbanks Morse internal starter motor, also a line of ball-bearings and samples of doublewear renewable finger tips. Represented by M. O. Southworth, Stephen Smith, F. M. Condit, E. C. Golladay, F. J. Lee and Joseph Dandie, of Chicago; H. E. Vogle, Baltimore.

General Electric Company, Schenectady, N. Y.—One of the features of this exhibit was a picture machine which showed classes of apparatus produced by the General Electric Company. In addition there was exhibited a turbo-generator set (type C Y-32-B 500-watt 32-volt) and photographs of switchboards and equipment for charging train lighting and baggage truck batteries. Represented by W. M. B. Brady, C. Dorticos, W. H. Wagner and W. A. Clough, of Chicago; H. W. Steward, G. W. Colman, B. C. Tracey, H. M. Jacobs and C. T. McLaughlin, of Schenectady, and W. J. Roche. Lind, Mass.

Gould Coupler Company, New York.—This company exhibited truck mounted generator suspension and adapter body type suspension. Type B. B.-9-B generator regulator, type A-9 combination generator and lamp regulator, type M-2 lamp regulator, type M-3 lamp regulator. A full working set direct drive for car lighting generator, new. A turbo-generator for locomotive headlight (500-watt 32-volt) new. Double compartment unit, set up with chemically pure plates. Wood sep-

arators rubberized and a submarine storage battery plate, plante type. Represented by W. F. Bache and M. R. Shedd, of Depew, N. Y.; P. H. Simpson, New York; G. R. Berger and B. W. Sackett, of Chicago.

Hart & Hegeman Manufacturing Company, Hartford, Conn. —This company exhibited lamp guards, snap switches of various sizes and porcelain receptacles for industrial and office lighting. It also displayed the "Paiste" line of pipe taplets. Represented by W. W. Winship, Haynes L. Everest, L. C. Church and A. Lubeck, of Chicago.

Kerite Insulated Wire & Cable Company, New York.— Exhibited samples of charging cable, power loads, headlight wire with special braid, both solid and flexible, car wire, stranded and flexible, and ignition wire. Representatives Azel Ames and P. W. Mills, of New York; J. A. Hamilton, G. A. Graber and W. H. Fenley, of Chicago.

Marlin-Rockwell Corporation (Insulated Wire Division), New Haven, Conn.—This company exhibited asbestos covered wires and cables, magnet wires, heater cords, nitrogen cords, fixture wire, stove wire, switchboard cable, moving picture cable, locomotive cable and sample forms showing how wire makes up for armatures. Represented by Ray P. Lee and Walter P. Lee, Chicago.

National Lamp Works of the General Electric Company, Cleveland, Ohio.—This company exhibited a reflector cap defusor, train and locomotive headlight lamps, the "Ivanhoe Ace," an enclosed unit for commercial lighting and a portable foot candle meter which is self-contained for reading foot candles direct from any position. In addition an interesting exhibit was displayed to show the progress of lighting since 3000 B. C. This exhibit showed the actual apparatus used during the various periods of time including the new white mazda lamp. Represented by C. W. Bender, J. E. Heeter and L. C. Kent, Cleveland, Ohio. The Ivanhoe Works of the General Electrical Company was represented by L. C. Doane.

Oliver Electric & Manufacturing Company, St. Louis, Mo. —This company exhibited locomotive headlight wiring appliances, such as headlight switches, terminal boards, junction boxes, plugs and receptacles, flexible conduit couplings, cab lighting fixtures and tender signal lamps, plugs and receptacles for shop wiring, terminal boxes, train light plugs and receptacles for car lighting. Represented by J. A. Amos, W. M. Graves, Jr., and Charles Gelan, of St. Louis, Mo.

Pyle National Company, Chicago.—Exhibited turbines as follows: Three to 10-kw. type M for train lighting; 2½-kw. type T for train lighting; 1500-watt type E; 500-watt type E-2 headlight; 500-watt type K-2 headlight. Also headlights in cases. New government standard interchangeable incandescent headlight with 18-in. reflector, Pyle National standard case 18-in. reflector, standard case with angle side number 30 deg. 18-in. reflector, Pyle National case 14-in. reflector, standard 18-in. glass reflector. Two and three wire connectors for train lighting or tank connections. No. 1450 micrometer focusing device, special cab socket for steam and water gage and dock lighting. No. 750 ball socket focusing device.

Railway Electrical Engineer, New York.—At this booth were copies of the *Railway Electrical Engineer* and other publications issued by the Simmons-Boardman Publishing Company, including the Locomotive Dictionary and Cyclopaedia and Car Builders' Dictionary and Cyclopaedia. Represented by C. L. Smythe, F. J. Fischer, P. Traeger, Jr., A. G. Oehler and C. J. Corse, of New York; N. H. Crossland, J. M. Rutherford, B. J. Wilson, C. L. Pfeiffer and B. W. Meisel, of Chicago.

Safety Car Heating & Lighting Company, New York.—This company exhibited underframe axle drive equipment with various types of regulating appliances and a few car lighting fixtures. Among their regulators appeared the type F lamp and generator regulator, the type F-1 lamp regulator and the type F-R lamp and generator regulator. Represented by A. Clark Moore, J. H. Rodger and C. A. Pinyerd, of Chicago; H. K. Williams and G. E. Hulse, New York; S. I. Hopkins, St. Louis; and V. S. Henry, Philadelphia, Pa.

Schroeder Headlight & Generator Company, Evansville, Ind.—The R. E-3 turbo-generator and U. S. standard locomotive headlight together with various parts of this apparatus was exhibited by this company. Represented by W. A. Carson, L. B. Jones and J. Henry Schroeder, of Evansville, Ind.; F. W. Edmunds, New York; H. A. Varney and E. B. Barris, of Chicago.

S. K. F. Industries, Inc., New York.—This company showed a line of Hess-Bright and S. K. F. types of ball-bearings for car lighting and headlighting work. The various sizes generally adopted by manufacturers of car lighting and headlight generators and headlight equipment were shown. Photographs were used to show the actual application of such ball-bearings as used in the railway field. Represented by H. E. Brunner, New York; S. B. Taylor, New York, and J. B. Costino, Chicago.

Stone Franklin Company, New York.—Exhibit consisted of a reducer panel to be used in place of the ampere meter panel, and a pole changer on a Stone-Franklin generator. Represented by R. G. Coburn and H. D. Rohman, of New York; H. C. Kloos, Chicago; R. H. Emms, Winnipeg, and W. L. Grey, Montreal.

Thompson Electric Company, Cleveland, Ohio.—This company exhibited a safety cutout hanger for hanging large industrial lamps in shops, roundhouses, yards and also for depot lighting. Represented by A. J. Thompson, Cleveland, Ohio.

Transportation Engineering Corporation, New York.—This company exhibited Edison storage batteries, an improved and rugged type of three-wheel tractor for railroad service, Rochlitz automatic water stills and battery charging equipment. Represented by H. G. Thompson and F. V. McGinness, of New York, and K. R. Hare, Chicago.

United States Rubber Company (Mechanical Goods Division), New York.—The particular feature of this company's exhibit was a hard rubber jar manufactured from high grade stock, the material and construction of which withstands considerable abuse and is practically unbreakable. The products or compound used in the make-up of this jar is by no means a new development by the United States Rubber Company for it has been manufactured and marketed by that concern for several years. However, it is only recently that this product has been presented to the railway field for car lighting use and this is the first time it has been on exhibition. In addition the exhibit included hard rubber pails and dippers for transferring sulphuric acid; hard rubber separators, end and side linings, moulded positive and negative terminal bushings, axle dynamo belts, cotton hose for covering generator leads, acid proof aprons and gloves, friction tape, rubber splicing tape, acetylene and oxygen welding hose. Represented by P. B. L'Hommedieu, New Brunswick, N. J.; E. C. Read, Louisville, Ky.; W. B. Mallette, St. Louis, Mo.;

W. B. Wise, New York; L. S. Hungerford, Jr., P. Parish, R. O. Hungerford, T. Plunkett, Lee Storms and D. M. Ayers, of Chicago.

U. S. Light & Heat Corporation, Niagara Falls, N. Y.—This company exhibited standard car lighting regulating apparatus including the ampere hour meter and their new small baggage car and coach equipment, including complete regulating apparatus. A 1½-kw. body-hung generator was also shown. Samples of new diagonally ribbed swadged battery plates, armature shafts, terminal boxes, and a cut-away generator showing the complete construction of such a machine. This company also exhibited its arc welding equipment including a complete direct current welder mounted on a truck with cable reel, control panel and three phase, 25-cycle, 440-volt driving motor. Also samples of electrode holders, face shields and accessories. An actual working exhibit was maintained at the U. S. Service Station, 3845 South Wabash Avenue, where demonstrations were carried on for the benefit of those who wished to avail themselves of the opportunity. Represented by W. L. Bliss, H. A. Matthews and R. Desmond, of Niagara Falls; E. C. Wilson, H. A. Morrison and W. R. Dudley, of Chicago; E. T. Sawyer, New York, and O. R. Hildebrant, Washington, D. C.

Western Electric Company, New York.—Displayed the W. E. railroad flood lighting lamp and portable utility light for railroad use. Also sunbeam lamps for all purposes. Habirshaw products were also exhibited including Habirlite locomotive headlight wire and cable light cord, railway signal wire, sector and concentric power cables and submarine cables. Western Electric representatives were George Hull Porter, L. A. Muttart, Chicago; G. W. Cramond, Cincinnati; T. Zogbaum, New York; G. J. McCall, Omaha; A. W. Hills, Detroit; J. A. Casey, St. Louis; A. L. Frankenberger, St. Paul; W. Turtle, American Lighting Company, Chicago, and Habirshaw representatives A. L. Carter, New York, and E. W. Kearns, Chicago.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.—This company maintained a booth but had no exhibit. Represented by R. L. McLelan, H. C. Mode and C. M. Harris.

The following companies were represented at the convention but had no exhibits:

Hazard Manufacturing Company, Wilkes-Barre, Pa.—Represented by T. A. Keefe, Pittsburgh; H. B. Pflasterer and George P. Cady, Chicago.

Loco Light Company, Indianapolis, Ind.—Represented by H. H. Tomlinson, Indianapolis, and C. E. Bleyer, Chicago.

National Carbon Company, Inc., Cleveland, Ohio.—Represented by J. M. Spangler, Cleveland, Ohio, and W. R. Pflasterer, Chicago.

Sangamo Electric Company, Springfield, Ill.—Represented by Edward Wray, Springfield.

Willard Storage Battery Company, Cleveland, Ohio.—Represented by Louis Sears and E. L. Myers, of Cleveland.

General News Section

One Hundred and seventy-three French Bridges were destroyed during the war, according to a report made public in Paris on August 18. The Somme bridges will be the first to be restored. Five of these have already been completed, and the clearing of the Somme canal and other waterways to permit navigation has been begun, 87 wrecked bridges thus far having been removed from the streams.

The sixth annual meeting of the Railway Fire Protection Association will be held at the Hotel La Salle, Chicago, on November 18, 19 and 20, inclusive, instead of October 21, 22 and 23, as was originally planned and announced. This postponement was effected by the executive committee of the association in order that railroad representatives serving in the dual capacity of accident prevention and fire prevention offices would be free during the month of October to devote all their time to conducting "National Railroad Accident Prevention Drive."

An Engineer on the Interstate Commerce Commission is the object of a campaign fostered by Engineering Council which has brought this matter to the attention of President Wilson, who will make the appointment, by a letter addressed to him, signed by J. Parke Channing, chairman of Engineering Council, which states in part: "The engineer's training fits him for that mode of thinking which is indispensable to impartiality of judgment. One important function of the commission is valuation of public utilities and another is the determination of relationships and responsibilities of the management of such utilities to the public. No other body of men has given so extensive and so scientific consideration to these matters as have members of the engineering profession."

The Results of the "Our Country First Conference," held in Chicago on September 8 and 9, under the auspices of the Illinois Manufacturers' Association, will be made effective by a permanent committee to represent the manufacturers of 36 states who attended this meeting. The committee, which consists of 16 men, among whom are four prominent railway and railway supply men, was selected to obtain a countrywide ratification of anti-red resolutions which are to be presented to Congress. Among these resolutions is one asking that the Interstate Commerce Commission decide the question of wages of railway employees as well as the rates. Following the performance of this duty, the committee will function as the agency of the manufacturers of the nation in propaganda work. The committee includes among others: Charles Piez, president, Link-Belt Company, Chicago, chairman; E. B. Leigh, president, Chicago Railway Equipment Company, Chicago; Alba B. Johnson, Railway Business Association, New York, and Samuel O. Dunn, editor, Railway Age, Chicago.

PERSONALS

E. M. Cutting, Pacific Coast manager for the Edison Storage Battery Company, with office at San Francisco, Cal., has been appointed manager of the railroad department, with office at Orange, N. J. Mr. Cutting entered railway work in 1888 in the signal department of the Southern Pacific. In 1898 he was appointed supervisor of signals for the Western division and in 1902, in addition to his duties in the signal department, he was given charge of all electric train lighting. In 1908 he became engineer of train lighting, heating and ventilation, resigning in 1912 to become Pacific Coast manager for the Edison Storage Battery Company, which position he held until his recent promotion. Mr. Cutting was instrumental in initiating the movement which culminated in the formation of the Association of Railway Electrical Engineers of which he was elected president in 1909.

E. M. Cutting

J. V. B. Duer, of the Pennsylvania Railroad, formerly assistant engineer in charge of the electrical department of the mechanical engineer's office at Altoona, Pa., was recently appointed to the position of electrical engineer with headquarters at the same place. Mr. Duer was born at Poultney, Vermont, on April 9, 1882. He received his education at Stevens Institute of Technology, graduating in 1903. Upon the completion of his college course he began work as an apprentice in electrical engineering with the General Electric Company at Lynn, Mass., and later completed this training at the Schenectady, N. Y., works of the same company. In May, 1906, Mr. Duer entered the service of the Long Island Railroad where he remained until May, 1910, when he was transferred to the New York Terminal Division of the Pennsylvania Railroad in the capacity of foreman of motormen. This position he occupied until December, 1913, when he was transferred to Altoona, Pa., when he became assistant engineer, which position he has filled until his recent promotion.

J. V. B. Duer

S. M. Viele, of the Pennsylvania Railroad, has recently been promoted to the position of assistant electrical engineer with headquarters at Altoona, Pa. Mr. Viele was born at Taylorsville, N. C., on January 28, 1886. After graduating from the North Carolina State College in 1905, he entered the testing department of the General Electric works at Schenectady, N. Y., where he remained until March, 1906. After leaving the General Electric Company he entered the employ of the Pennsylvania Railroad as a draughtsman. Later he

William S. Hart, assistant general superintendent of manufacture of the Hazard Manufacturing Company, Wilkes-Barre, Pa., with headquarters in that city, has been appointed district manager of that company's sales department with headquarters at Chicago, succeeding Albert W. Gabriel, who has resigned to engage in other business. Mr. Hart was born in Wilkes-Barre, Pa., on January 13, 1872. Hen entered the service of the Hazard Manufacturing Company on September 11, 1886, as spooler boy. From that beginning and until 1903 he was engaged in various capacities in the different departments. On the latter date he was appointed assistant foreman, two years later he was transferred to the sales department with headquarters at Pittsburgh, Pa., and on February 1, 1916, he became assistant sales agent with the same headquarters. Two years later he was transferred from the sales department to the manufacturing department, having been appointed assistant general superintendent of manufacture. He retained that position until his recent appointment as district manager of sales at Chicago as mentioned above. On September 11, 1919, Mr. Hart completed his thirty-third year of continuous service with the Hazard Manufacturing Company with the exception of eight months from February to October, 1898, when he served as first lieutenant, Company D, Ninth Pennsylvania Volunteers in the Spanish American war.

William S. Hart

Leonard S. Fuller, who recently became assistant manager of the Ohio Brass Company, insulator factory at Barberton, Ohio, was honored with the

degree of Ph.D. in electrical engineering by the Stanford University in recognition of his work in wireless. Dr. Fuller did some notable work in connection with the laboratories of the Federal Telegraph Company at Palo Alto, California.

L. S. BILLAU, assistant electrical engineer on the Baltimore & Ohio, located at Baltimore, Md., was elected president of the Association of Railway Electrical engineers at the eleventh annual convention of that association which was held at the Hotel Morrison, Chicago. Mr. Billau graduated from the University of Minnesota in 1905 with the degree of electrical engineer. After graduation he took up work in the testing department of the General Electric Co., specializing in heavy traction. In 1909 he accepted a position with the Baltimore and Ohio in its electrical department. Since then Mr. Billau has filled a number of positions in that department. A few years ago he was appointed assistant electrical engineer which position he still holds.

L. S. Billau

JOHN H. RODGER, western manager of the Safety Car Heating & Lighting Company, was elected president of the Railway Supply Manufacturers' Association at the annual convention of that association, which was held in the Hotel Morrison, Chicago. Mr. Rodger entered the railroad supply field with the Standard Coupler Company, New York. After several years' activity with this company he was appointed assistant to the president of the Monarch Machine Company, of the same city, and in 1911 accepted a position as representative of the Safety Car Heating & Lighting Company, with headquarters at Chicago. During the war, Mr. Rodger held the position of acting vice president of this company in the absence of A. CLARK MOORE, who was commissioned a major in charge of aircraft production for the New York district. Upon Mr. Moore's return, Mr. Rodger was made western manager of the Safety company, which position he still retains.

J. H. Rodger

TRADE PUBLICATIONS

Harvey Hubbell, Inc., Bridgeport, Conn., has recently issued a new catalogue on the subject of reflectors for industrial plant lighting known as schedule "C." A very large number of reflectors of all types and sizes are shown. The pamphlet which measures 8 in. by 10½ in. contains 26 pages including the cover.

Electric Traveling Cranes.—A new catalogue of Chesapeake cranes has been compiled by the Chesapeake Iron Works, Baltimore, Md. The book contains 28 pages, 9 in. by 11½ in. The first half is devoted to descriptions and illustrations of the various parts of the cranes, while the last half contains full page illustrations of installations.

The Allis-Chalmers Manufacturing Company of Milwaukee, Wis., has recently issued its bulletin No. 1106 in which is illustrated and described a new line of direct current motors and generators known as the Type "E." A number of exploded views are given in which are shown all of the points of advantage in this new line of machines.

The Esterline Graphic for October points out some of the advantages in the use of Esterline graphic meters for general testing. It states that graphic instruments are used on poles, in manholes, beneath electric locomotives, on mine locomotives and in such places where it would be impossible for an observer to remain for hours or days at a stretch.

Harmony in Fixture Design is one of the points emphasized in the September-October number of "Eye Comfort." A number of illustrations are presented which clearly bring out the advantages of having the fixtures correspond with the interior decorations. Another section is devoted to stage illumination and a number of photographs are shown illustrating this apparatus in detail as well as one showing its installation in the theater.

C-H Drum Control is the title of a new 4-page, 2-color, 8½-in. by 11-in. folder which has been prepared by the Cutler-Hammer Manufacturing Company of Milwaukee, Wis. The pamphlet outlines the features of the C-H drum controllers such as their accessibility and interchangeability of parts, also the interchangeability of methods of manipulation. Any C-H standard stock drum can be equipped with either rope, radial or straight line drive, and these are interchangeable. Connections, rating and other engineering data are given

The Edison Storage Battery Company, Orange, N. J., has commenced publication of its house organ, "The Grid," of which the October number is the first issue. It is an attractive little pamphlet, 6 in. by 9 in. and consisting of 26 pages including the covers. The contents are partially devoted to the uses of the Edison storage batteries in the various industries and partially to humorous articles on different subjects. One article, "The Road to Arcady," runs through six pages of the magazine and makes very interesting reading.

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AN OPPORTUNITY TO BROADEN OUT

The question of the Association of Railway Electrical Engineers joining the American Railroad Association, which was brought up for discussion at the recent annual convention of the former body, is one that offers considerable food for thought on the part of the electrical engineers. For a long time the electrical men on the railroads have been using their best endeavors to have accorded to them a larger measure of executive responsibility in matters pertaining to electrical affairs.

On some roads they have succeeded to the extent that real electrical departments have been organized which have complete charge of all matters which logically fall within the limits of its activities. This condition, however, is not the case on the majority of roads for a number of reasons. In some instances the amount of electrical work is not sufficient to make a separate electrical department practical or even desirable, but on the greater number the chief reason is because the men in charge of this work have not made the most of their opportunities to search out solutions for the big electrical problems. They have been satisfied to handle the smaller routine matters which fall more within the scope of the electrician than the engineer. This practice, is due in not a few instances to the fact that the men who are in charge of the electrical work are electricians and not engineers.

On the other hand, there are those who have had better training and are capable of exercising engineering talent if they were given the opportunity and it is this latter class that would be very greatly benefited if the Association of Railway Electrical Engineers became a part of the American Railroad Association. At the present time the former association is the only one of the railroad engineering societies that is not a member of the latter body. The electrical engineers have nothing to lose in joining the larger association, but on the contrary, have everything to gain. They will, of course, lose their name as an association but their identity would not be destroyed and what is much more important they would receive recognition by having the large electrical problems referred to them for solution. When this point is reached, and it is the inevitable outcome of the amalgamation of the two associations, the real electrical engineer will come into his own, while the man who can only measure up to the standard of an electrician will automatically eliminate himself from the large electrical projects.

BIG BUSINESS AHEAD

The railroads have had to handle a record-breaking freight and passenger business during the past few years, and the indications are that business will continue to increase, particularly if too much time does not elapse before industrial conditions become stabilized. Because of war conditions the roads have not been able to make sufficient additions to their equipment and facilities to take care of ordinary replacements, let alone making permanent provisions for the increase in business. Just as soon as satisfactory arrangements are made for financing the roads they will have to go into the market for vast quantities of equipment.

As an example, consider passenger cars, which will make an especial appeal to the electrical engineer because of the car lighting possibilities.

Between 1910 and 1917 the number of passenger cars in service increased from 47,095 to 55,941. In 1918 only 131 passenger cars were ordered for all the railroads and in 1919 no substantial orders have yet been placed, although of late there have been a considerable number of inquiries. Meanwhile from 1910 to 1916, the increase in the number of passengers carried one mile was 36 per cent. In 1917 the increase over 1916 was 14½ per cent; the increase in 1918 over 1917 was 8 per cent; and for the first eight months of 1919 the increase over the corresponding months of 1918 was 6.3 per cent.

The 50 per cent increase in passenger rates in June, 1918, did not discourage travel as might have been expected; the travel in August, 1919, for instance, increased 12 per cent over the same month of 1918, and the increase for September, 1919, as compared to the same month for 1918 was even greater.

The car lighting engineers will do well to keep these facts in mind and be prepared for making the necessary recommendations for the large amount of electric lighting equipment which will have to be ordered in the very near future.

YOUR PART IN AMERICANIZATION WORK

We commented in the October number of the *Railway Electrical Engineer* on the necessity for giving more attention to the Americanization problem. Those who have given this question critical attention and study claim that Americanization is not a matter of language or customs, though these play an important part, but rather that it is a question of spirit. How can foreigners gain a real conception of American ideals, if they do not come into intimate contact with Americans —if they do not meet Americans socially, or see them in their homes?

Many people have dismissed any responsibility for a part in Americanization work because they say the government has established a bureau for doing this work. It must be remembered, however, that the government can only go so far with its organized work and that it must depend upon citizens generally to do their part in adding the finishing touch to the job, even if they do not have to do it all. You may say that you do not come in contact with foreigners in your district, but is this true? Are there not some, even in the employ of the railroad, that you can help if you will but look about you?

There are certain sections of the country where there are very few foreigners, but nevertheless there may be a great necessity for Americanization work among illiterates, or even among those who vote and class themselves as American citizens, but who have no real understanding of American ideals. The future welfare of this country and its influence on other countries—for we are no longer an isolated nation—depends on raising our ideals to a higher and higher standard. You can at least help by promoting patriotic demonstrations and giving encouragement to educational efforts along the lines of Americanization and civics.

APPRENTICES IN THE ELECTRICAL DEPARTMENT

The special rules for electrical workers, incorporated in the shop employees' wage agreement with the Railroad Administration, which became effective October 20, makes provision for the training of both regular and helper apprentices. The schedule for regular apprentices includes 12 months on inside wiring and electrical repairing, six months outside line work, six months locomotive headlight work, six months car lighting department, six months armature winding, and 12 months general electrical work. The schedule for the helper apprentices is similar except that the first and last items are shortened to six months.

The steady increase in the number of electrical workers on steam railroads makes imperative a real effort to attract and train desirable and capable young men for this work. These schedules are good, but they will fall far short of the requirements if they are not administered in the right spirit, accompanied by a certain amount of technical instruction which should be given in a class room on company time. Moreover this class room work must be simple, practical and espepecially designed for electrical workers on steam railroads. It has been demonstrated in shop apprentice courses that it is quite necessary in order to secure a real interest on the part of the apprentice that the theoretical problem be intimately related to the practical work on which the boy is engaged in the shop; in other words the technical and practical instruction must be co-ordinated and the classroom instructor must have a keen appreciation of the practical problems which confront the boy in his daily work.

Too little attention has been given to the apprentice problem in the electrical department, but the growth of this department and the necessity for recruiting the ranks with efficient, well trained workers now make it necessary to give it special attention.

A LARGE FIELD FOR ELECTRICITY ON STEAM RAILROADS

So steadily and yet so rapidly has the application of electricity been extended to various departments of steam railroads that it is doubtful if many railroad officers fully realize the important part which it now plays in the operation of the roads. In its electrical night programs the New York Railroad club has heretofore confined itself to the discussion of the electrification of steam roads. Its program for Friday evening, November 21, is therefore of peculiar significance. Twelve minutes will be devoted to the presentation of each of six phases of the application of electricity to steam roads. One of these applications will, of course, be a review of important developments in connection with the program of electrification. In addition to this, however, there will be considered electric welding; electric shop power and light; electric car lighting; electric storage battery trucks for station, freight house and shop use; and the use of electricity in connection with freight and cargo handling machinery.

Although the initial expense of installing various kinds of electrical equipment may in some instances appear to be excessive, the fact should not be lost sight of that this first cost is very soon absorbed in the increased efficiency secured. Because electricity plays such a large part in increasing production and saving labor, it is quite probable that it will be in even far greater demand on railroads. The roads are several years behind in their facilities and equipment and just as soon as they are turned back to their owners and proper measures are taken to finance them, a tremendous effort will have to be made to add to their equipment and facilities. Realizing this, it is up to the electrical engineer to recommend the use of electricity or Xelectrically operated devices wherever they can be used to advantage.

Railroad Electrification Facts and Factors

Why the Electro-Pneumatic System of Control is Superior to the Electro-Magnetic Method

By A. J. Manson

In the September issue, the electro-pneumatic control was described in detail. The construction of the unit switch, various numbers of which can be assembled to form a group of switches, was taken up and discussed. In this article we will continue with the subject of control and discuss other parts and how they are combined together to make up a complete equipment for the operation of an electric locomotive.

As pointed out in the previous article the electro-pneumatic system of control has been universally adopted. It is now the standard. The electro-magnetic system has been used considerably up until three or four years ago but it has certain disadvantages. The electro-pneumatic system has the advantage in that the switches are operated by air, and a constant pressure is thus obtained between the contacts carrying current independent of what the voltage may be on the third rail.

With air any desirable pressure can be obtained at the contacts. The air pressure supply can be varied, or the size of the switch cylinder can be varied. It is an interesting fact that the amount of current that can be carried by a pair of contacts for a given temperature rise depends on the pressure between the contacts. The greater the pressure the more the current that can be carried for a given temperature rise, or in other words, the less the temperature rise with a given continuous current. An idea of what the pressure between a pair of contacts 1 in. wide means, is shown by Fig. 1. These curves show how the capacity of the contacts can be increased. For instance, at 90 lb. pressure on the contacts, with 300 amps. flowing there is a temperature rise of 60 degrees C., but if the pressure is increased to 365 lb. the contacts will carry 600 amps. continuously for the same temperature rise. Again with 365 lb. pressure the temperature rise is 60 degrees C. but if the pressure is reduced to 255 lb. the temperature rise will be 80 degrees C.

In the case of the magnetic switch, it is closed by a solenoid, so that if the voltage to this solenoid reaches too low a value, the pull of the solenoid will be decreasd, and the pressure will be less. On heavy traction systems this is not much of a factor, as the third rail voltage is usually nearly constant and does not drop appreciably with heavy loads. On smaller systems, where the feeder supply is not on the same basis, the voltage may be reduced considerably. The low voltage occurs at the time that maximum current is flowing through the contacts, so that there is liability of the contacts becoming "frozen" or "welded."

Another advantage of the electro-pneumatic system is that the control circuit is of low voltage. A storage battery, usually of 32 volts supplies the power for operation of the electro-pneumatic switches. All of the control circuits are at this voltage and all forms of interlocking can be readily used. With the electro-magnetic system the 600 volt supply is generally used for the operation of the solenoids and the control circuits. While all of these circuits are amply protected by fuses, still the low voltage battery control circuit is desirable.

The engineer, sitting at the front part of the electric locomotive has complete control of the switches and auxiliary apparatus and hence the control of the locomotive through the master controller. Take for instance an electric locomotive equipped to operate on both alternating and direct current, with pantograph for collection from the overhead trolley wire and wtih shoes for collection from the third rail, the raising and lowering of each of these is under the control of the engineer. Air pressure is used to operate the shoes and pantograph, and this air pressure to the operating cylinders is controlled by magnet valves, which in turn

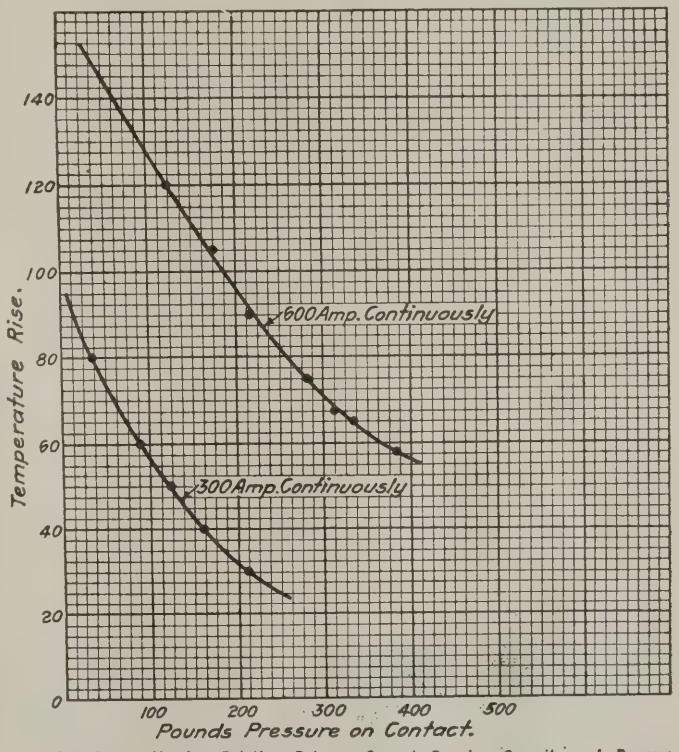


Fig. 1. Curves Showing Relation Between Current Carrying Capacity and Pressure on Contacts

are controlled by push buttons located on the master controller. The battery current passes through the contacts of the push button, when closed, and energizes a valve similar to the valve described for the unit switch. With this remote control, the third rail shoes can be dropped previous to entering on the direct current zone, and the pantograph lowered, and when leaving the direct current zone, the pantograph and shoes can be raised. Sand can also be applied to the rail. A means is further provided so that the circuit breaker can be reset automatically by the engineer, when it has opened due to overload caused either by too rapid notching up of the controller, or to a failure in some part of the main circuits. The battery current is connected to a small trip coil which unlocks the overload trip, returning it to its normal

*Westinghouse Electric and Mfg. Company, New York.

position so that the battery current can again energize the magnet valves used to close the circuit breaker switches. When resetting the circuit breaker the master controller must be thrown to the "off" position so that the breaker can not be reset with the switches closed and in an operating position. This condition could exist with the locomotive at a standstill unless the interlocking was used.

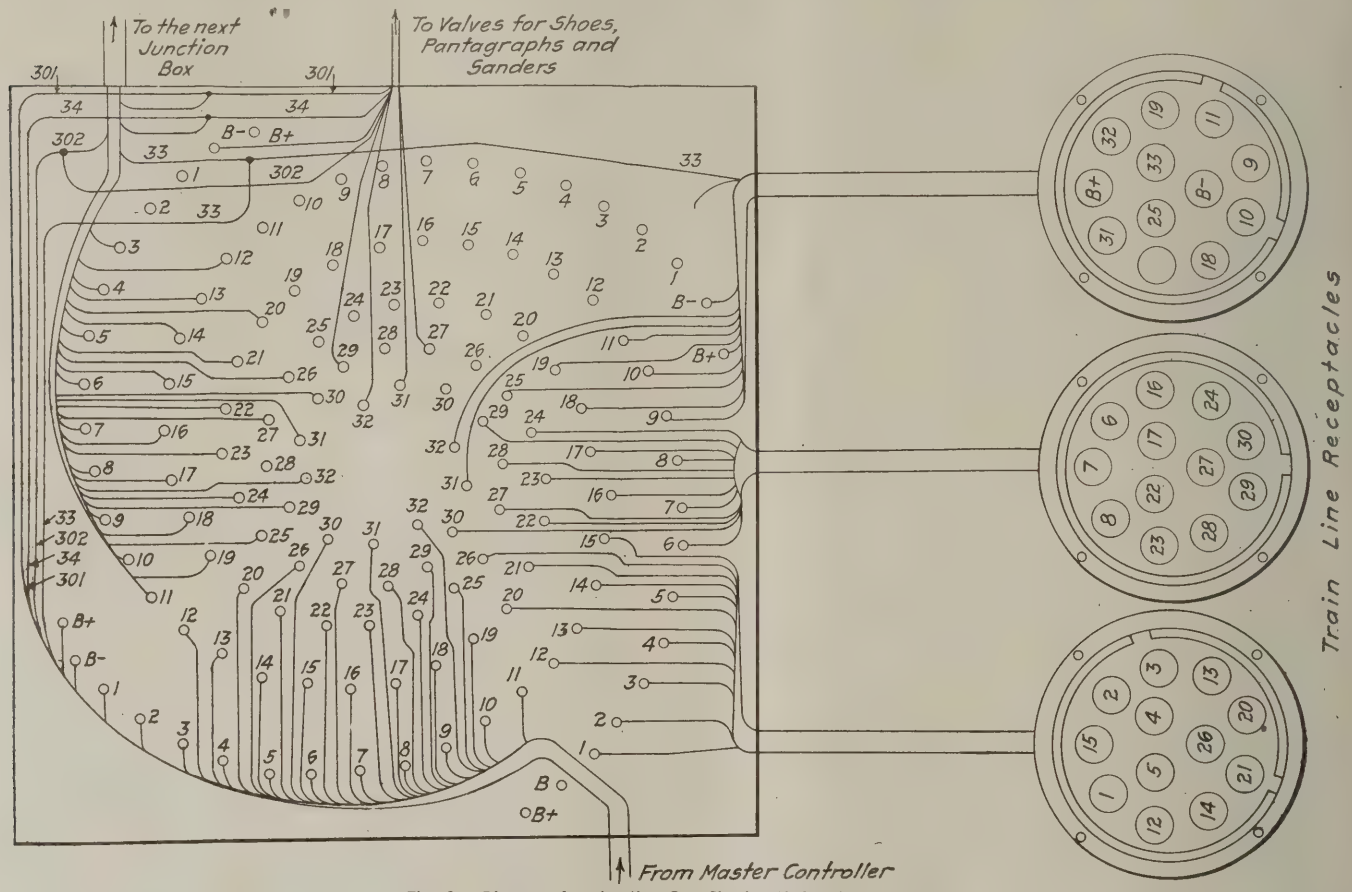


Fig. 2. Diagram of a Junction Box Showing Train Line Receptacles

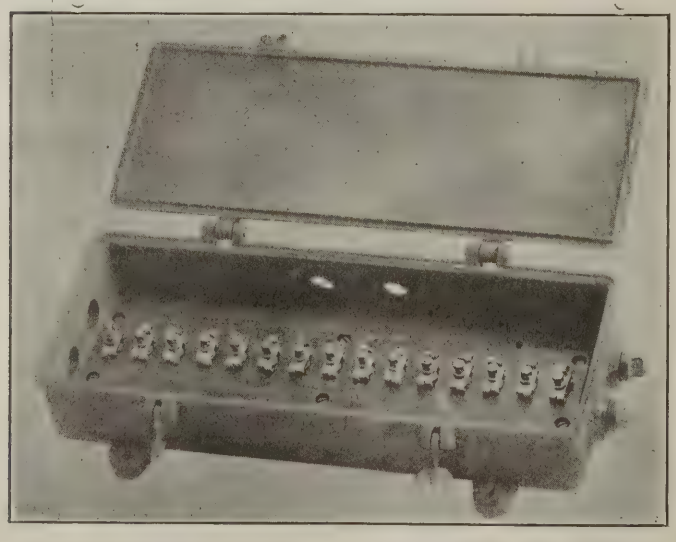


Fig. 3. A Small Junction Box Showing Terminals, Clips, Studs and Conduit

With the large number of control circuits required for the operation of an electric locomotive, the wiring at first seems complicated but after the principle is understood, it is simple. These control wires are led to the various pieces of apparatus from the master controller. To provide easy installation, junction boxes are provided where connections are made to the train line wires. The diagram of such a junction box for a large electric locomotive is shown by Fig. 2. Generally three of these junction boxes are used per locomotive so that all control wires are available near the

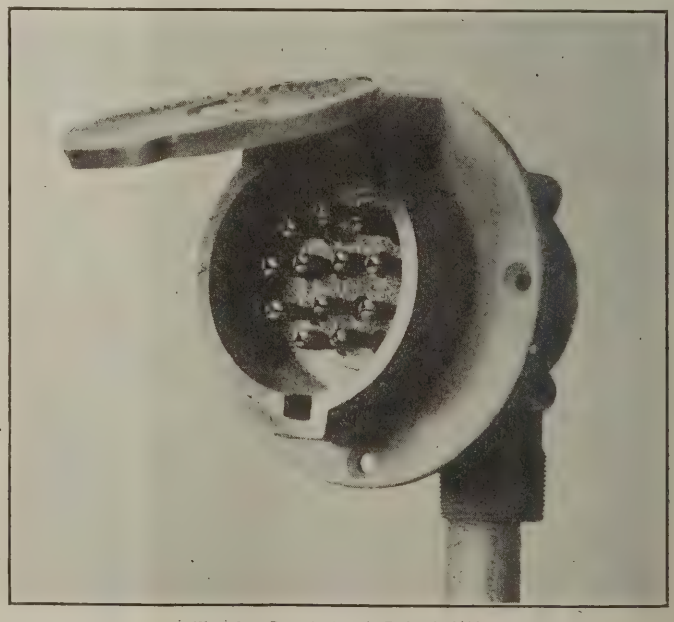


Fig. 4. Receptacle at End of Cable

piece of apparatus to which they connect. The junction box shown by Fig. 2 is one of the end boxes located near the master controller. One of the advantages of

electric locomotive operation is the possibility of operating locomotives as double headers, under the control of one man at the front end. To accomplish this, the control wires must pass from the head locomotive to the rear locomotive, so that when a particular wire is energized it not only brings in a certain switch in the leading locomotive but the same switch is brought in, in the rear locomotive. The train line wires are carried to the rear locomotive by train line

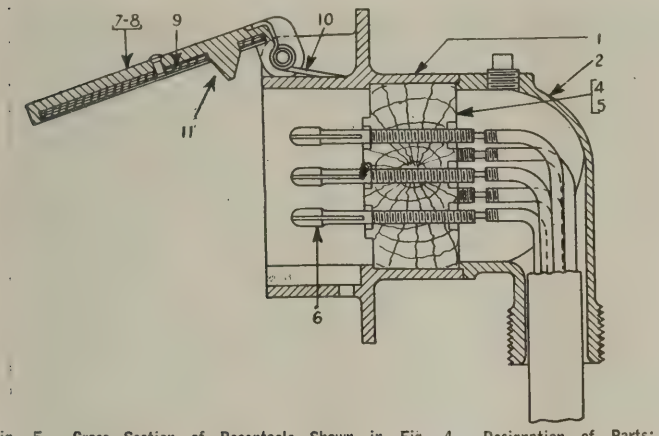


Fig. 5. Cross Section of Receptacle Shown in Fig. 4. Designation of Parts; 1. Base Casting; 2. Cover; 4. Wood Contact Support; 6. Plug Contact; 7. Lid; 9. Leather Cushion; 10. Lid Spring; 11. Lug

receptacles and jumpers. The method of connection is shown in Fig. 2. In this particular case three 12-point receptacles are required to handle the 35 train line wires. The jumpers plug into the receptacles and carry the control wires across the space between the two adjacent ends of the locomotives. It will be noted that there are four terminals each of the same number, one at either side of the box. All four terminals of each number are connected together at the back of the insulated slab on which the terminals are mounted, so that connection can be made to the most convenient

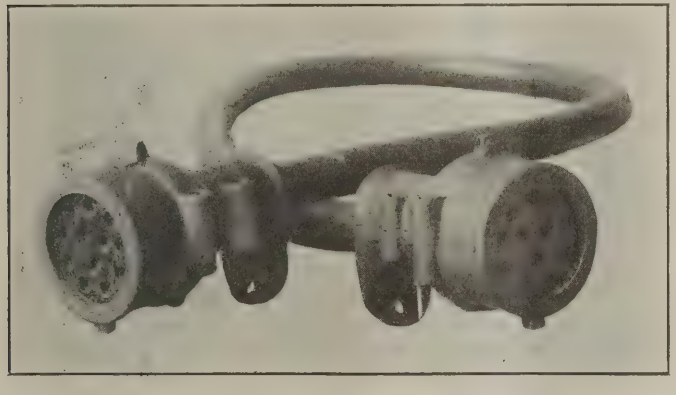


Fig. 6. Jumper Used to Connect Two Receptacles Such as Shown in Fig. 4

stud and there is no congestion of terminals on one stud. For instance, a wire coming from the master controller connects to the No. 3 stud. One of the train line receptacle wires connects to another No. 3 stud, and a wire from a third No. 3 stud enters the pipe leading to the other end of the locomotive. When the No. 3 wire is energized in the master controller each of the above two mentioned wires is energized. Each stud carries small terminal clips, as shown in a smaller junction box illustrated by Fig. 3. These terminals are soldered to the control wires entering the box, thus furnishing a ready and convenient method of connection.

Junction boxes are drilled and tapped on the end and sides to allow the conduit carrying the control wires, to be connected to the box thus giving a continuous conduit protection to the wires. Lugs are also provided so that the junction box can be fastened to the ceiling of the cab, the most convenient location.

The appearance and construction of the receptacles are shown by Figs. 4 and 5 and of the jumper, by Figs. 6 and 7. In either the receptacle or the jumper the leads, entering the back of the casting are soldered to

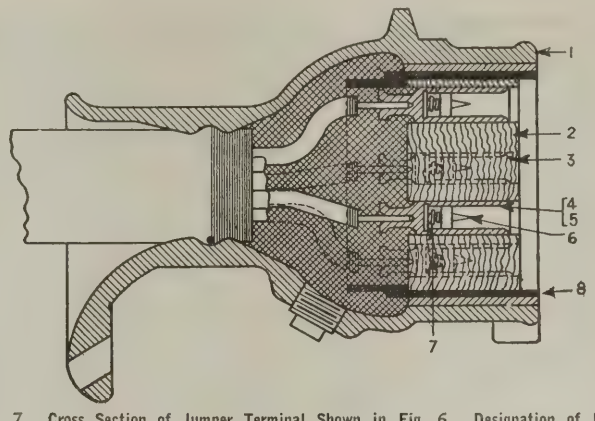


Fig. 7. Cross Section of Jumper Terminal Shown in Fig. 6. Designation of Parts; 1. Plug Castings, Upper and Lower Half Bolted Together; 2. Wood Contact Support; 3. Brass Sleeve Contact; 6. Wedge; 7. Spring for Wedge; 8. Insulation

the contacts, alcohol and resin being used, or some neutral soldering paste. The parts are assembled and then the cavity or space back of the contact support is poured full of ozokerite, a thick black compound which hardens on cooling. The jumpers at each point of contact are fitted with a wedge, a small sharp pointed piece, which enters the plug contact of the receptacle when the jumper is pushed into place expanding same and insuring good contact. The lid on the receptacle, is provided with a lug which laps over a corresponding lug on the jumper and prevents the jumper loosening and falling out due to vibration.

In the next article we will discuss the methods used in connecting the motors to the circuit, in the various combinations, for both direct current and alternating current operation.

AN OLD CRANE MODERNIZED

The Lane Mfg. Co., Montpelier, Vt., established for 70 years, built its first rope-driven overhead traveling crane about 40 years ago. Many of these cranes installed in the early eighties are still rendering full service.

Until this year all efforts of the company have been confined principally to the stone-working field. About 1898, with the increased development of electric power, the Lane crane was adapted to electric drive, and during the past twenty years a large number of these electrically-driven cranes have been installed largely in their original field—the stone-working industry—throughout the country. Most of the installations, however, have been in the New England States. Hence, although so long established, it is easy to understand why the Lane crane has not been better known in fields outside of the stone-working trade.

A notable characteristic of the Lane Electric Crane is the employment of two motors for the three movements. Both motors are the constant speed, nonreversing type, which eliminates the use of controllers and complex wiring. Control of all movements, including that of direction by means of a series of friction

cones, is mechanical. This design effects a saving in electric power which is ordinarily lost in frequent and quick stops and reversals, and speeding up or slowing down of variable speed reversing motors.

Originally Lane cranes were furnished with timber bridge girders, stayed with steel truss rods fastened to cast iron bridge trucks, and having a safety factor of about 7. This construction has the advantage of being

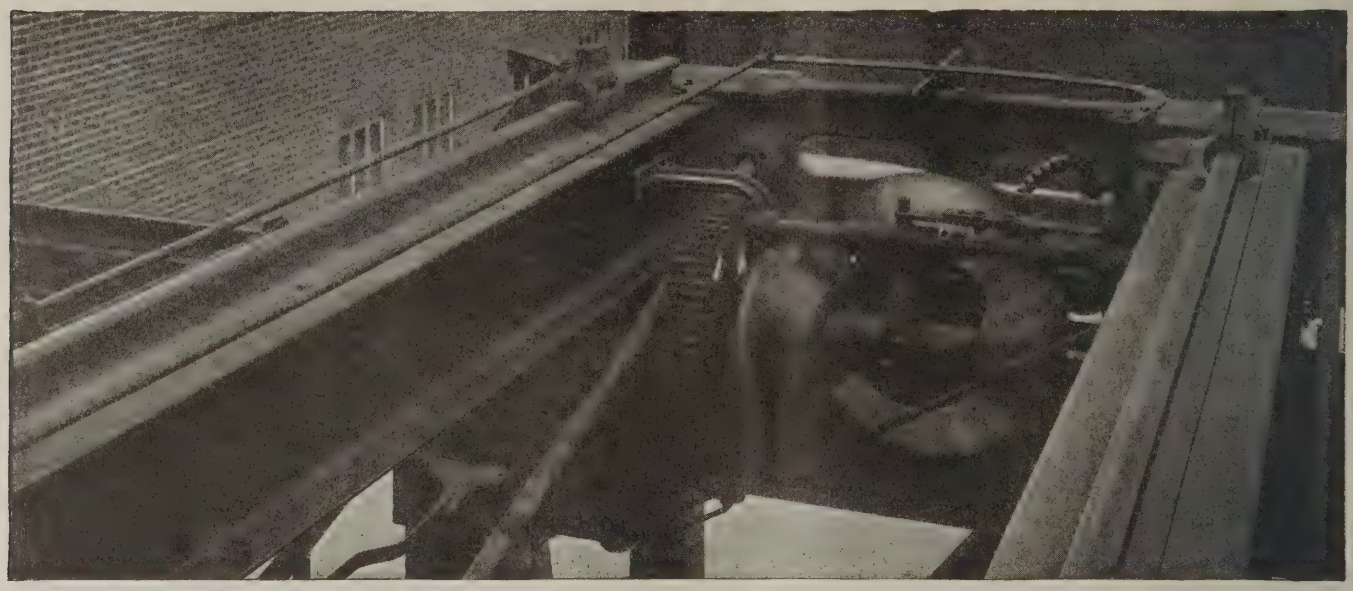


Fig. 1. Power for Hoist and Trolley Movements is Transmitted by Friction Cones Through Steel Worms, Engaging Bronze Gears Running in Oil

exceptionally light for a given capacity. Where desired timber bridge girders are still furnished. In fact, bridges are now supplied in three styles:

No. 1.—For short spans; rolled steel I-beams, reinforced with inverted channels riveted to the top flanges when necessary.

No. 2.—Steel girders of the lattice box section type for long spans.

No. 3.—Heavy timbers of long-leaf yellow pine, reinforced by large steel truss rods.

In all cases, these bridges are designed with a large factor of safety—at least 5, and with ample strength to sustain the load without undue deflection, horizontally or vertically.

The bridge girders of this crane are supported by cast iron end trucks, provided with cast iron double flange chilled wheels, which have steel axles running in renewable bearings. The trolley which is made of cast iron, is designed for rigidity, compactness, accessibility of all parts, and is suitably reinforced with steel tension rods. The sides are joined together by several large steel shafts. Power for hoist and trolley movements is transmitted by friction cones through steel worms engaging bronze gears running in oil. These friction cones are plainly visible in Fig. 1.

The worm-gear drive is a simple and effective load brake, being controlled by a convenient hand wheel. Two speeds of the hook are furnished with one part of rope. A luff block is provided with a hook and hinged housed sheave, so that by running the line through this sheave and attaching the single rope hook to a girt on the underside of the trolley a two-part reaving of the rope is affected, thereby dividing the first two speeds by 2 and doubling the power, supplying 4 hoist speeds. The following are approximately the speeds for a 10-ton standard crane:

No load—40 feet per minute with one part of rope.
2½ tons—20 feet per minute with two parts of rope.
5 tons—10 feet per minute with two parts of rope.
10 tons—5 feet per minute with two parts of rope.

The hoist motor, through the same power cones, operates the trolley motion on the bridge at approximately 100 feet per minute. The reverse is obtained in the same manner as with the hoist movement. All movements are controlled by hand wheels. There is no complicated wiring, there are no large controllers and there are no hot resistances, hence, no ability to handle delicate electrical equipment is required of the operator.

The bridge motor drives a friction disc by transmission through a pair of opposed cones, alternately contacting therewith. Control of the bridge travel movement in either direction is effected by shifting the cones by means of a lever connected to a rod running the full length of the bridge convenient to the operator's left hand.

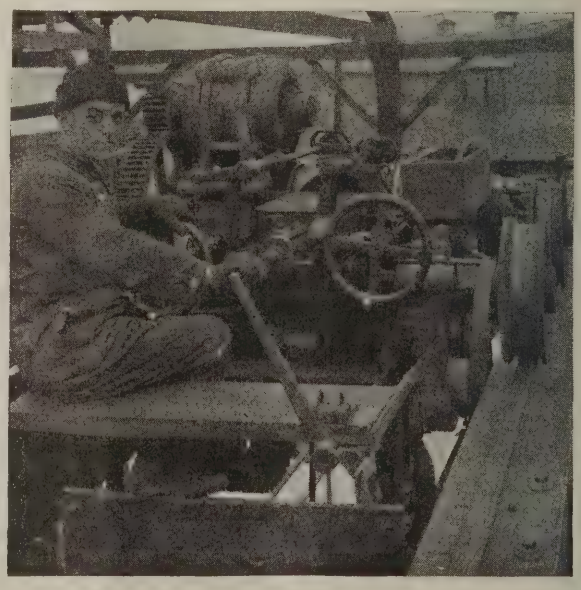


Fig. 2. The Operator is Seated on the Crane Where He Has a Clear View of the Hook

A History of Steam Railway Car Lighting

From the Candle Light to the Present Electric System Service Has Been the Main Object

By E. Wanamaker
Electrical Engineer, Chicago, Rock Island & Pacific

A RESUME of the history of railway train lighting compiled from the records available shows that great strides have been made in the art since the days of the first experiments. To one Thomas Dixon, driver of the coach "Experiment" on the Stockton & Darlington Railway, in England, in 1825, is given credit for having first used artificial light in a railway car. This coach, built by the Liverpool & Manchester Railroad, had been leased by Dixon and was operated by him for several years in the service mentioned. It was horse-drawn and had seats along the sides to accommodate six or eight passengers. Thomas Dixon was a man of generous motives, and having in mind the comfort and convenience of his passengers on dark winter nights he placed a penny candle on a table, also provided by him, in the center of the car. From this humble beginning railway train lighting has grown and kept pace with the development of illumination in other fields and with the growth of other transportation facilities. Today, electric systems for lighting cars cost hundreds of dollars per car and a large number of workmen are necessary to provide and maintain this service.

A review of the progress made in developing car lighting shows it is divided into periods of approximately 25 years for each illuminant used. Each new system, however, has not entirely replaced the one which preceded it, for we still find candles serving as emergency sources of light, and oil and gas are still widely used both as auxiliary and primary systems.

The period of candle light lasted from 1825 to 1850, when oil lights were introduced. Oil lighting in turn gave way to gas in 1875, and gas continued to be the most generally used illuminant until about 1900, when the application of electricity to car lighting began to receive wide attention by railroads, and in this country at least is now the system generally preferred for new equipment. One reason for this is the improvements which have been made in incandescent lamps. Beginning with the old carbon-filament lamp with an efficiency of approximately 3.50 watts per candle, there came in turn the metalized filament or gem lamp of 2.5 watts per candle, the tantalum lamp of 2 watts, the tungsten type "B" lamp of 1.25 watts, and now we have the mazda "C" lamp, consuming in the sizes most commonly used for car illumination .75 watts per candle, or a consumption of power of less than ¼ of that originally required, and still further improvement is in prospect. Not only, however, has there been progress in increasing the efficiency of the lamps, but the quality of the light has been improved as well and tungsten lamps are very much more satisfactory in this respect than were the carbon lamps.

The carbon lamp first met with competition when the flat-flame gas lamp was introduced, and again when the Pintsch mantle was developed; this form of light seemed for a time likely to delay the general use of electricity for train illumination. With the introduction of the tungsten lamp, however, the advantage which gas had in the form of better quality of light was removed, and today electricity seems assured of holding its place as the principal illuminant for this class of service.

The methods and materials used for car lighting have been in general the same as those used for other purposes; but the application has differed in order to make these methods suitable for car lighting requirements. For example, the simple system of candle lighting required special holders. The earliest holders were plain sockets, but as the use of candles was extended, these were replaced by fixtures more adapted to train service and today we have candle lamps which combine with the fundamental requirements of a socket or holder, a glass chimney, canopy, and a coiled spring underneath the candle to force it upward and thus keep the flame at the same position in the chimney.

Even greater progress has been made with oil lamps. This type of lamp was simply an outgrowth of the candle, the only difference being that in the oil lamp the illuminant was supplied in liquid form in a reservoir provided for the purpose, while in the candle lamp the illuminant is in solid form and is changed to a liquid as needed. under the heat of the flame. The first oil lamps in cars were of the ordinary flat, or round, wick type, but as the demand for a high-powered and steady-burning lamp increased it was met first by an arrangement employing two wicks for a single flame and later by lamps of the center-draft type.

Oil lamps when placed in the center of the car are provided with smoke bells and ventilators to carry off the products of combustion and protect the flames from drafts. Many cars are still being lighted with oil lamps and as much as 50 candlepower has been obtained from a single lamp of the center-draft type.

The use of coal gas as an illuminant was tried as a head-end system, the supply being carried in one of the head cars in a reservoir under slight pressure produced by water displacement, from which location it was carried through pipes and rubber hose to the other cars of the train. In 1867, the Pintsch system was invented and since that time has been perhaps the strongest competitor of the other car-lighting systems.

The first gas lamps used the ordinary fish-tail burners, but in the early fifties Robert W. Bunsen, while fitting out his laboratories at Heidelberg, developed the burner which bears his name, and a modification of this burner made possible the mantle lamp. After years of discouraging results a mantle was produced which was satisfactory for car-lighting service. In February, 1905, a coach on the Pennsylvania Railroad was equipped with mantles. This coach was exhibited before the International Railway Congress at Washington in March of the same year, after the mantles had been given a thorough test in actual service.

The "Straight Storage" System

The earliest electric system of which we have a record was a straight storage system used on the London,

*Abstract of a paper presented at the opening meeting of the Western Railway Club, Chicago, on September 15.

Brighton & South Coast Railway in 1881. Primary batteries were also tried in France in 1885 on cars operating between Paris and Brussels. At about this same time straight storage lighting was tried by the Pennsylvania Railroad and the Boston & Albany in the United States, and on the first-mentioned road this was for many years the electric system most used.

The present straight storage system consists of either 16 or 32 cells of lead battery, mounted in a box underneath the car. Charging receptacles are mounted on each side of the car to provide connections for charging at each terminal. The battery is connected to the distributing panel inside of the car where fuses and switches are provided to control and protect the lighting circuits.

This system requires an expensive charging plant at each terminal, the wiring of which must be so laid out that cars can be charged from most any point in the yard and the generator be of such capacity as to handle the maximum number of cars at one time. The main disadvantage is the limited time which a car can be kept in service without being held for charging and the liability of light failure due to batteries becoming discharged when trains are delayed or held from regular charging terminals. Another disadvantage arises from the fact that cars equipped with this system cannot be operated on branch lines or at isolated points where charging facilities are not available.

The Head End System

Head-end equipment was first tried in 1887, when it was installed by the Pullman Palace Car Company in one of its composite cars operating between Jersey City, N. J., and St. Augustine, Fla., in the Atlantic Coast Lines Special. This equipment consisted of an 80-volt, 80-ampere, Eickemeyer dynamo direct connected to a three-cylinder Brotherhood engine running at 1,200 r.p.m. In the same year, the Pennsylvania Limited was similarly equipped, and in 1888 the Chicago, Milwaukee & St. Paul also had a train equipped in a similar manner. The equipment, however, differed from those used by the Pullman and Pennsylvania companies in that it consisted of a boiler, engine, generator, etc., mounted in a special car for supplying both light and heat to the trains. This system was later replaced by its present standard system of taking steam from the locomotive.

Besides the Brotherhood engine, the Westinghouse standard engine, Curtis and DeLaval turbines have been employed for head-end lighting, but of these two types of prime movers, the turbine seems to be preferred generally and today has practically replaced the reciprocating engines formerly used. One reason for this is the vibration produced by the reciprocating engine which, under certain conditions, is noticeable throughout the whole train.

The head-end system was first tried out with a generator in the baggage car and no batteries, but due to frequent light failures caused by the trains being parted and the locomotives being cut off at division points, it was found necessary to place batteries on the first and last car of each train so that if a train was parted to cut out or cut in cars, each section would have light. This system worked fairly well, but on heavy trains the load was so great that the battery capacity could not be depended upon to carry the full load for any length of time, in case of failure of the generating unit or steam not being available from the locomotive. To take care of that situation, in some cases, batteries were applied to each car. This greatly increased the time that lights could be depended upon in case of the generator unit being out of service and also made it possible for each car to have light when cut out.

Various means are used to control the lamp voltage and battery charging rates, some roads using automatic regulators for controlling the lamp voltage, others use an adjustable resistance in the baggage car to adjust the lamp voltage for the whole train, being operated by the baggageman or electrician, and some have individual lamp voltage regulators in each car. Each road seems to have developed this system to meet conditions as they existed on its particular lines, which has resulted in several different schemes of wiring, battery charging and operation, all of which give results more or less satisfactory.

An axle-driven head-end system has been designed to furnish power for lighting the train and charging the batteries from a single unit, the batteries being

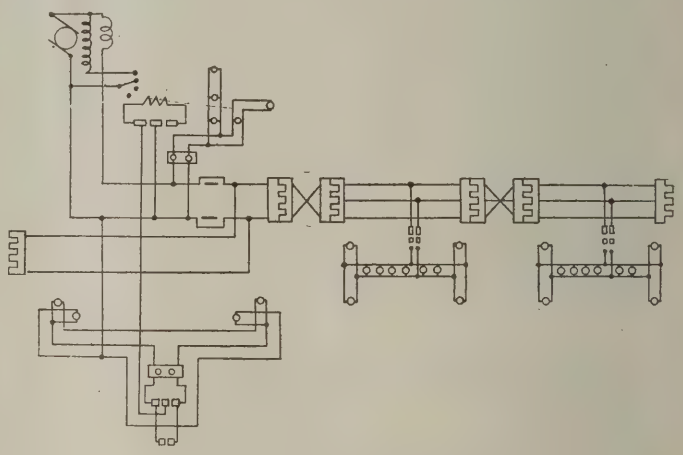


Fig. 1. Wiring Diagram For Two Car Suburban Service

distributed throughout the train, as for instance, one set in the baggage car, one in the observation or dining car, and sometimes one in the middle of the train. The number of batteries used and their location are governed by local conditions.

While this system is not liable to light failures, due to lack of steam, it has the same disadvantage as the steam driven head-end systems, namely, that cars not equipped with batteries are dark when cut out of a train, that they are not interchangeable when operating on foreign lines and are liable to light failure due to small battery capacity when trains are delayed or tied up. It would, therefore, seem that this system is unsatisfactory for universal operations.

For suburban and branch line service, the straight head-end system without any auxiliary battery has been found very economical and successful. The present practice for this class of service is to mount the turbo-generator on the locomotive in a manner similar to that used for mounting headlight turbines, the generator being of sufficient capacity to furnish current for the headlight and cab lamps and the maximum number of cars usually assigned to this class of service.

The standard three-wire system of wiring and standard train line connectors are used for making connections between cars and locomotive. No doubt, in the near future this system will be used more extensively on branch lines due to the low first cost, low maintenance cost, and the ease with which the installation can be made to existing power and rolling stock. A schematic diagram of the complete wiring in a two-car

train is shown in Fig. 1. All cars are similarly wired, and the number of cars in a train is only limited to the capacity of the turbo-generator and train line wires. Low first cost results from the simplicity of the car wiring system, which includes only a train line circuit and one lamp circuit connected to it with a fused knife switch in a steel switch box.

The turbo-generator on the engine should have an A. I. E. E. rating at least equal to the maximum demand that will ever be made upon the equipment. At the time the initial installation was made on the Rock Island suburban trains, it was impossible to procure a turbo-generator with a capacity greater than 2½ kw.; however, fair service was obtained; but in order to secure a large factor of safety, the author is in favor of a 5 kw. capacity equipment.

The "Axle Lighting" System

Credit for the earliest attempt at lighting a train with axle-driven equipment is given to the London, Brighton & South Coast Railway, in 1883. Since that date development has gone on unceasingly, and individual axle-driven systems are now most generally used for train illumination in this country.

Car_____ **BELT MILEAGE**

MONTH	MILES	MILES	MILES	MILES	MILES	MILES	MILES
	1914	1915	1916	1917	1918	1919	1920
Jan.							
Feb.							
Mar.							
Apr.							
May							
June							

Fig. 2. Card For Belt Mileage Records

Generators for axle lighting service differ in many respects from the ordinary generators used for furnishing electricity for lighting or other purposes. Many unusual conditions must be met. The axle generator must be practically dust and water tight so as to operate under all kinds of weather conditions, through water, snow and sand. This requires an enclosed generator with gaskets on all covers. The ventilation inside of generator must, therefore, be lost sight of and the circulation of air around the outside of the generator depended upon to assist in keeping the generator at a safe operating temperature.

Since cars operate in either direction and at all rates of speed perfect commutation is necessary over a wide range of speed in either direction. This is accomplished by setting the brushes for full load for the average train speed, which gives fairly good commutation at speeds below or above the average. The correct polarity is maintained by shifting the brush holders or reversing the armature connections by some mechanical device.

The shunt wound generators in use today vary only in minor details such as the pole changer mechanism, bearings and other mechanical details from the generators first used. Pole changers have been improved, and ball bearings and roller bearings are replacing the old sleeve type bearings. With the adoption of ball barings, failures and the cost of maintenance have been greatly reduced.

The Rosenberg generator, which has certain inherent characteristics, as used in this country is a modification of the Rosenberg generators used in Europe, which are of the self-regulating constant current type, while the ones used in America have been modified to give a constant potential. This type of generator requires no pole changers since its electrical characteristics are such that the same polarity prevails regardless of the direction of rotation of the armature.

Belts and Suspension

After years of test only one form of transmission for driving the generator is in general use. Various forms of leather link belts, "V" belts, chains, gears, rubber, canvass and leather belts and direct drive have been used, but due to the variable relation between the axle pulley and the armature pulley, and the climatic conditions, the rubber belt up to the present has been found to meet the requirements most economically.

Some of the first generators were suspended from the car body, others were mounted on the truck. For a long time the most common means was to provide a cradle at the end of the car truck on the outside of the end sill for the dynamo to rock on or to provide two arms out over the end of the truck from which the dynamo was suspended by parallel links. These suspensions were known as the cradle and parallel link types. Much time has been spent in improving generator suspensions, which has resulted in the elimination of many wearing parts, thus simplifying and reducing the maintenance costs.

The body hung suspension is favorable to the maintenance of the generator and possibly to the car truck. With it the belt is considerably longer than with the truck type suspension. Therefore, the belt life must be increased in the some proportion as the length is increased in order to keep the belt cost per car mile the same. Much is claimed for both types of suspensions, each having its possibilities, the conditions under which they operate and the condition in which they are maintained being important factors.

An important point in connection with axle lighting is the proper application of axle pulleys. No matter how well designed a suspension or equipment may be, if the pulley is not properly applied, the belt life will be short and the maintenance cost high, due to loss of belts. In some cases axle pulley are applied to eccentric axles; these should have been turned to insure a perfect pulley seat. In some cases pulleys are applied with improper pulley bushings. Eccentric pulleys and small belt clearance over the brake beam comprise two of the main causes of short belt life. Farsighted mechanical men on some roads have made provisions for successful and economical operation of the belt drive by using turned axles or by turning a pulley seat on hammered axles to insure concentric pulleys. Also in some cases special brake rigging is being used to give ample belt clearance.

Maintenance

To secure good service from the entire equipment at a low operating cost a standardized systematic method of maintenance must be used. With the present design of equipments the belt cost constitutes the second largest single item of expense. Records should be kept from which individual belt mileage can be computed. Cards similar to Figs. 2 and 3 may be used. The car mileage which will be recorded on the card in Fig. 2 is furnished monthly by the car accountant's office. The dates belts are applied are entered upon card, Fig.

3, from the "Car Lighting Performance Report," Fig. 4, which is furnished daily from each point where inspections are made. From these reports any car using an excessive number of belts will be noted and steps taken to correct any defects which cause the loss of belts. A monthly report showing average belt mileage should be furnished supervising officers so that they will keep closely in touch with operating conditions.

At the periodical shopping of cars the electrical equipment should be thoroughly overhauled and placed in a first-class condition, all worn parts being removed and defects corrected. If this is done thoroughly heavy repairs will seldom be found necessary between the shopping periods. The date of this overhauling should be recorded on a card similar to Fig. 5, to be kept in the regulator locker.

A systematic inspection of the generator and suspension should be made each trip to see that all parts are in good condition. Any repairs that are made should be recorded on report, Fig. 4, which is sent to the electrical engineer or to the office in charge of car lighting. Once each year the generator should be dismantled and all parts thoroughly cleaned, fields and armature painted with insulating varnish and new grease applied to ball bearings.

Train Line Facilities and Fixtures

On the majority of railroads, facilities are provided for making connections from car to car so as to provide light in a defective one. It is almost the unanimous opinion of car-lighting engineers that with the present equipment, facilities for train-line connections are essential if light failures are to be avoided, connectors being especially desirable for the protection of mail cars.

The tendency in connection with fixtures is toward simplicity of design to harmonize with the interior construction of the car. Center-deck lighting seems to be generally preferred with a sufficient number of units, properly shaded, to give uniform distribution. Enamel finishes the same color as the car walls or ceiling at the point where the fixtures are located are most used, but there is a reason for believing that in time the roads will again prefer metal finishes, as these, when properly applied to fixtures of pleasing design, help to improve the interior appearance of the car. In recent years statuary bronze has been the metal finish most used.

A matter of great importance is that of careful selection and design upon which depends the effectiveness of the installation, both as regards light distribution and appearance. These various questions involve a study of intrinsic brilliancy, intensity, distribution and color.

Batteries

There are two distinct types of storage battery in use in car lighting service at the present time, the lead acid battery and the nickel-iron alkaline battery. Of the lead batteries there are two general types of plates, the Plante and the Faure.

In the Plante type of plate the active material is formed out of pure lead. The construction is such that a large surface for acid contact is possible. The Faure type plates are made up by applying the active material by some mechanical process such as mixing a paste and spreading it on a grid or plate, where it sets or hardens as it drys. Of each of these types there are numerous variations. For a given output, the Plante is more costly, more bulky, and heavier than the equivalent pasted plate type. Thus far this type is more durable and better able to withstand the operating conditions incidental to car-lighting service. It is the type most used in car-lighting service, but some car-lighting engineers claim that the advantage it has had over the pasted plate type is decreasing with the increased cost of labor and improved methods for battery protection. The nickel-iron alkaline battery is of comparatively recent development and is radically different from the

Car_____ **BELTS APPLIED**

KIND	ACCOUNT	POINT	DATE	KIND	ACCOUNT	POINT	DATE

Fig. 3. Record Card For Dates When Belts Were Applied

lead acid battery. It is light in weight and mechanically rugged.

The cost of maintaining batteries constitutes the largest single item of expense in the maintenance of car-lighting equipment, and the entire development of regulators or apparatus for battery protection while the car is enroute has been with a view of prolonging the life and reducing the cost of maintenance. However, good standard practice for handling batteries is also essential if this cost is to be kept within reasonable limits.

In the handling of lead batteries, regular yard inspection should be made carefully as follows: Upon arrival of the car in the yard the gravity of the pilot cell should be taken. The height of the acid should be noted and the result compared with the previous readings. This is done best by maintaining a record card, similar to Fig. 5. This card to be kept in the regulator locker, and all readings as they are taken should be recorded on it. The lamp load should be turned on for about five minutes and a voltage reading taken of the battery and light circuits. This should also be recorded on the card, to serve as a check on the gravity reading. Overcharge of storage batteries is not always indicated by the voltage or gravity. Excessive overcharge or an excessive charging rate would be indicated by an abnormal temperature or by the presence of acid on the covers of the battery cells caused by violent gassing.

A less violent overcharge or charging rate would be indicated by too frequent flushing of the battery. If the record card, Fig. 5, indicated that the flushing period is less than six months the battery is being overcharged or charged at an improper rate. For flushing only distilled water should be used.

With this method of yard inspection and car-lighting record system each inspector has a complete record of the operation of each car. If the inspections are made carefully and compared with previous records, abnormal conditions will be noted and remedied before any material damage will have been done to the battery. Should the gravity be 25 points below normal, the battery should be charged in the yard until fully charged as indicated by the gravity and voltage.

Cleanliness is of primary importance in handling car-lighting batteries. The battery compartment should be

inspected and periodically cleaned and painted with an acid-proof preparation, the top of the battery box should be dust tight to prevent the dirt which accumulates on top of the box from falling through onto the batteries. Vent plugs should be kept in place and connectors carefully maintained. Inspection should be made for leaky tanks and necessary repairs made. Leaky tanks are caused generally by electrolysis due to grounded tanks. The use of slatted or skeleton trays, however, will materially reduce trouble caused from

ROCK ISLAND LINES

CAR LIGHTING PERFORMANCE REPORT

Car_____ Train—In_____ Out_____

Place_____ Date_____

Apparatus Working_____ Lights Fail_____

Sp. Gr._____ Height of Acid_____

Volts Battery_____ Volts Lights_____

Battery Charged_____ Hours_____ Amps.

Belt_____ Train Conn._____ Fans_____

Lamps Missing_____ Burnt Out_____ Applied_____

Oiled Generator_____ Cond. of Eq'pt on Departure_____

CAUSE OF FAILURE AND MATERIAL USED

Signed_____ Inspector

Mail Original Report to Electrical Engineer, Chicago.
Place Duplicate in Locker.

Fig. 4. This form is Four Inches Wide and Seven Inches Long Printed on Thin Paper

this source by allowing the acid to escape from around the tanks in the event that any is thrown out of the cell.

Office records should be kept of the life of each set of batteries. The records should show the location of the battery and date last cleaned, and condition at that time. See Figs. 6, 7 and 8, Fig. 8 being opposite side of Fig. 7. The period between cleaning should be such that when the battery is taken out of service for cleaning it will not have been subjected to any bad effects, such as short-circuited plates due to sediment in the bottom of the tanks, etc. This period will depend upon the regulation of the charging current, and the conditions under which the battery operates.

Proper battery protection and low pick up train speed will prevent the battery from being overcharged and will reduce the cycles of charge and discharge, respectively, thus lengthening the cleaning period, prolonging the battery life, and appreciably reduce the maintenance cost. New battery elements should be applied in complete sets. Any plates found to be defective at the periodical cleaning, should be removed and a complete new set applied to the battery. The elements in the defective sets, which are all right for further service, should be used to fill in other partially defective sets, provided they have lived up to any existing agreement which may be in effect with the manufacturers as regards length of service, etc. Using this method of handling elements will insure uniform capacity of all cells in each set of battery.

The design and construction of storage batteries for car-lighting service have not been improved to any great extent in recent years. Different manufacturers have brought out various small changes in some of which the improvement has been more fancied than real. For instance, various kinds of tanks, such as stone, glass, rubber, lead, etc., have been brought out in an attempt to secure one which would stand up in car-lighting service. Of these the lead tank is the only type in universal car-lighting service at the present time. Lead tanks, however, have certain disadvantages, such as trouble from electrolysis which is caused by grounds. It is probable that recent development in the manufacture of hard rubber tanks will again bring that type back into car-lighting service, as such tanks have certain characteristics which are superior to the lead tank if they can be made sufficiently strong.

With the present design and construction, the cleaning period is comparatively short. By a change in design the same capacity could be maintained and yet the space for sediment could possibly be doubled, thus greatly prolonging the cleaning period, insofar as it is based on this particular feature. Some manufacturers are now endeavoring to produce a battery which will not have to be removed from the car for cleaning during the life of the positive element, or at least to prolong the cleaning period far in excess of present practice.

The nickel-iron battery must be kept dry and clean and care must be taken to prevent dirt or other substances from collecting anywhere about the battery. Periodically the battery should be removed and both compartment and battery thoroughly cleaned. Dirt, if allowed to accumulate, collects moisture and forms a good conductor. This causes electrolysis to set in, which would soon damage the metal containers. Occasionally after the battery and compartment have been cleaned, the cells and trays should be painted with an alkali-proof paint.

The life of the electrolyte varies according to the conditions under which the battery operates, but when a decrease in capacity or voltage is noted, a quart sample of the solution should be sent to the manufacturers for their analysis and recommendations. Should the electrolyte need renewing, new solution should be secured from the manufacturer. Only distilled water should be used for flushing.

As there is practically no change in specific gravity between a fully charged and a discharged condition, the gravity reading cannot be depended upon to determine the state of charge of the battery. Where lead and nickel-iron batteries are both maintained, care must be taken to keep the utensils used for the nickel-iron type separated from those used with the lead type, because sulphuric acid is injurious to the nickel-iron battery. The metal parts of the connectors and posts and the tops of the containers must be kept clean and coated with vaseline to prevent electrolysis, and to prevent the clogging of the gas vents, which, if allowed to become stopped up, may cause the container to burst under the pressure of the gas generated on charge or discharge.

If a cell becomes defective in operation it should be sent to the manufacturer for repairs or replacement.

Battery Protection

The control of the generator output while the car is enroute has offered one of the most difficult problems to be overcome, since the life of battery and lamps depends to a large extent upon regulation.

Without the proper protection, the battery life may be only a third of what it should be. In a small manner also the cost of maintaining the generator depends upon the regulation.

The duties of the regulator for car-lighting service are:

(1) To connect the battery to the generator at the minimum speed and voltage for which the machine is designed to operate and to disconnect the battery when the speed and voltage fall slightly below the first mentioned value, (2) to provide a variable voltage to charge the battery at the proper rate, which is determined by the state of charge, and at the same time carry the lamp load, in the event it is turned on, up to the capacity of the generator, (3) when the battery has attained a full state of charge, the regulating means must prevent further charge thereafter, leaving the generator capable of supplying current to lamps or other translating devices, (4) to provide constant voltage on lamps while car is in motion or at rest.

There are two types of regulators in general use, designed with the view to meet these requirements: (1) Ampere hour meter control (2) potential control The first mentioned method charges the battery by starting at a high rate, which is gradually modified to a predetermined lower rate, and when a predetermined number of ampere hours have been put into the battery as indicated by the meter, a contact in the meter is closed, after which the potential is reduced by the regulator sufficiently to prevent further charge. With this method it is necessary, for proper battery protection, to maintain the ampere hour meter in step with the state of charge of the battery. To compensate for the inefficiency of the battery, the meter is designed to run slower on charge than on discharge, and if the battery is maintained in a normal condition the proper ratio of charge to discharge is maintained.

It is apparent that the proper battery protection depends not only on the proper functioning of the meter itself, but also upon the battery remaining in normal condition in order that the battery and meter may remain in step with each other. Owing to battery characteristics and operating conditions, the meter does not always indicate the true state of charge.

To maintain the meter and battery in step it is necessary to frequently check the gravity and potential readings with the meter readings, making corrections as necessary. The addition of the ampere hour meter to a car-lighting regulator adds another device which requires a highly skilled artisan to maintain.

In the second method of charging heretofore referred to as "potential control," inherent characteristics of the battery are taken advantage of to govern the charging rate, and when the battery has attained a full state of charge, to prevent further charge thereafter.

Before going further into this method of charging it should be understood that the charging of a battery may be likened to the charging of an air reservoir in

CAR NO._____

CAR LIGHTING RECORD

For Ball Bearing Dynamo. Grease every six months with one-half lb. R. I. Standard ball bearing grease to each bearing. Enter date and place greased below.

PLACE	DATE

REGULATOR SETTING

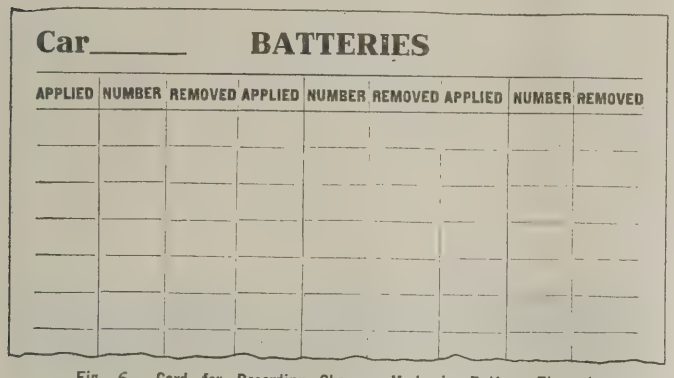
PLACE	DATE	COIL		AUTO SW.		LAMP REG.	
		FOUND AT	SET TO	FOUND AT	SET TO	FOUND AT	SET TO

GRAVITY VOLTAGE AND FLUSHING RECORD

BATTERY CHANGED

DATE	SP. GR.	VOLT.	FLUSH	DATE	SP. GR.	VOLT.	FLUSH	DATE	SP. GR.	VOLT.	FLUSH	DATE	SP. GR.	VOLT.	FLUSH

at least one respect, that is, as soon as the charging begins the battery counter electro-motive force or back pressure offers opposition to the flow of current into the battery, and the charging rate will be determined by the difference between the potential or pressure of the power supply line and the counter potential, or back pressure, of the battery, and when the opposing potentials or pressures become equalized, current will cease to flow. In the case of a battery, if the charging rate is in excess of what it should be, the battery will

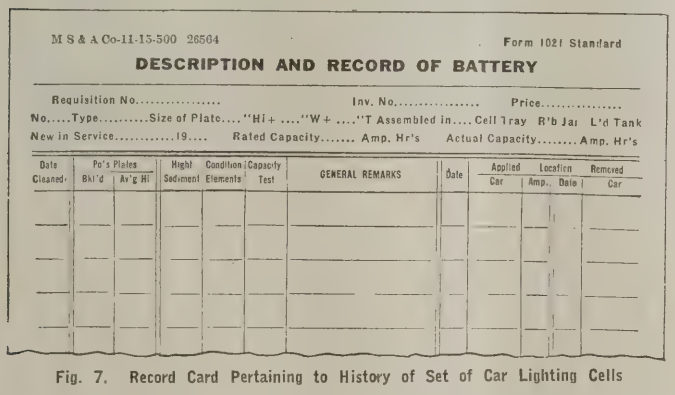

Car_____ BATTERIES

APPLIED	NUMBER	REMOVED	APPLIED	NUMBER	REMOVED	APPLIED	NUMBER	REMOVED

Fig. 6. Card for Recording Changes Made in Battery Elements

be caused to gas, and the evolution of gas bubbles which form along the surface of the plates tends to separate the solution from contact with the plates and increases the internal resistance in the same manner that foaming in a boiler tends to decrease the water contact along the inner surface, thus increasing the resistance offered to the passage of the heat to the water. In both cases the results are inefficiency, together with more or less destructive effects to the battery elements and solution.

With a battery there is a limit to the counter potential to be obtained, which has been defined by a number of eminent engineers to be 2.3 volts per cell. Any apparent counter potential attained above this value is due to the evolution of gas which, as stated above, increases the internal resistance and will indicate an apparent higher counter potential.


M S & A Co-11-15-500 26564 Form 1021 Standard

DESCRIPTION AND RECORD OF BATTERY

Requisition No..... Inv. No..... Price.....

No.....Type.....Size of Plate....."Hi+ ...."W+ ...."T Assembled in....Cell Tray R'b Jar L'd Tank

New in Service.....19.... Rated Capacity..... Amp. Hr's Actual Capacity..... Amp. Hr's

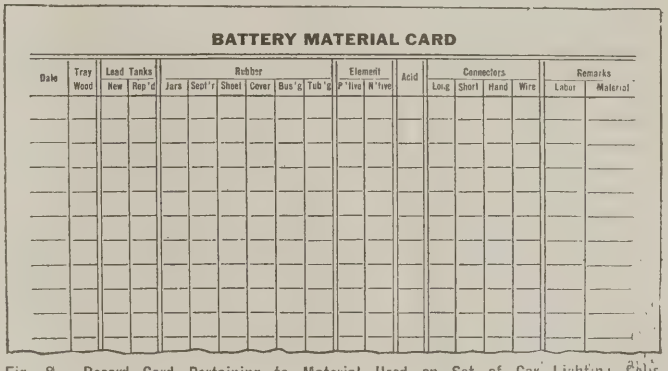
Date Cleaned	Po's Plates Bkl'd	Po's Plates Av'g Ht	Hight Sediment	Condition Elements	Capacity Test	GENERAL REMARKS	Date	Applied Car	Location Amp.	Location Date	Removed Car

Fig. 7. Record Card Pertaining to History of Set of Car Lighting Cells

In the potential control method of charging, the generator voltage is limited to some predetermined value. This is accomplished by what is known as a carbon pile regulator, which consists essentially of a carbon disc rheostat in series with the dynamo field circuit, the resistance of which is varied by an electro magnet, thus automatically adjusting dynamo excitation to maintain a proper voltage value to charge the battery regardless of train speed, above the cutting-in speed.

With most potential control equipments, a current limit feature is embodied with the potential regulator to hold the maximum current to a value consistent with the generator capacity. With this method the battery is charged at the highest possible rate that can be used without causing the battery to gas, and when the battery is fully charged further charge is impossible, provided the maximum potential does not exceed 2.3 per cell.

Many forms of potential control equipments have been placed on the market, most all of which operate at potentials such that in the course of charging, the battery is caused to gas. In 1913 and 1914, efforts were made by the Rock Island to operate equipment at a maximum voltage of 2.3 volts per cell. At the beginning the experiment was found to be a failure, as in many instances cars on most runs arived at terminals with the batteries in a decidedly discharged state. There were, however, cars in fast main line service on which the batteries remained in a full state of charge and at the same time were not being overcharged, the batteries requiring flushing on an average of about every six months. This was encouraging and led to investigations which developed that the failures were not due to the fact that the low voltage would not keep the batteries charged but resulted from the fact that this voltage of 2.3 volts per cell was not attained except at very high train speeds. In one test covering a period of 5 hours,


BATTERY MATERIAL CARD

Date	Tray Wood	Lead Tanks New	Lead Tanks Rep'd	Rubber Jars	Rubber Sept'r	Rubber Sheet	Rubber Cover	Rubber Bus'g	Rubber Tub'g	Element P'tive	Element N'tive	Acid	Connectors Long	Connectors Short	Connectors Hand	Connectors Wire	Remarks Labor	Remarks Material

Fig. 8. Record Card Pertaining to Material Used on Set of Car Lighting Cells. This Form is printed on the opposite side of Card shown in Fig. 7

the equipment maintained full voltage and load for less than 10 per cent of the running time. On the face of the evidence it looked as though a larger generator designed to give full voltage and load at a lower train speed would be required, but fortunately after further investigation it was found that with certain refinements in the regulating device, a lower cut-in speed could be secured. Briefly speaking, the building-up period of the generator was prolonged on account of a resilient effect of the carbon pile form of rheostat which controls the generator output. To remedy this condition a more powerful regulating magnet was required.

A test made with an improved regulator with the same generator that was used on the previous test and over the same run, showed the following comparison:

Full load—Old regulator—35 miles an hour.
Full load—Improved regulator—24 miles an hour.
Full load time in 5 hours—Old regulator—10 per cent.
Full load time in 5 hours—Improved regulator— 41 per cent.

In this case the capacity of the unit was increased 300 per cent.

The net results realized from the use of the improved regulator are increased capacity of the unit due to obtaining generator output at low train speed, and increased battery life, which is brought about by the following:

(A) The work imposed upon the battery of furnishing energy for the lights is greatly reduced by the increased

working time of generator, and also by the fact that the current for the lights is supplid by the generator, and not by the battery, at all times after the generator cuts in.

(B) The battery is charged at the proper rate to prevent gassing and overheating with their attendant ill effects.

(C) The battery is protected from overcharge and the forming away of the reserve lead in the battery elements.

The same general control methods used for the lead battery are also used for the Edison battery, the principal difference being that a higher potential is required for charging the Edison battery.

The two main causes of an abnormal condition in a lead battery are shorted cells, caused by buckling of the plates or by high sediment in the bottom of the tanks, and sulphation, caused principally by the action between the acid and the plates when the battery is in a discharged state. Analyzing the respective abilities of the two methods of control to protect the battery when in this condition, we find the following:

With the ampere hour meter control, if one or more cells become shorted, the remaining cells would be protected from overcharge. However, the charging rate may be slightly increased.

With the potential method of control, if one or more cells become shorted the voltage is slightly increased on the remaining cells. In the case of one shorted cell the increased voltage imposed upon the other cells is so very slight that it would have but little effect before the trouble would be removed.

The question of shorted cells is not a serious matter with either method since with the present system used for maintaining batteries, comparatively few cells become shorted. At one of the Rock Island main terminals where approximately 1400 inspections per month are made, an average of one shorted cell per month is experienced.

In the case of sulphation it would seem that the potential control has an advantage over the ampere hour meter control, since in the case of a sulphated battery it is very difficult to predetermine the ampere hour charge required to break up the sulphate. With the ampere hour method a predetermined number of ampere hours are put into the battery which is fixed for a battery in a normal condition. With the potential control method the sulphate would affect the rate but the charge is not limited to a predetermined number of ampere hours, and our experience is that all ordinary cases of sulphation are broken up without any readjustment of the equipment or charging in the yard.

Even though only a part of the Rock Island equipments have been improved, the cost of operation and maintenance per car per month has not increased, in spite of the increased cost of labor and material, and a very large part of the savings is attributed to the better protection provided for the battery.

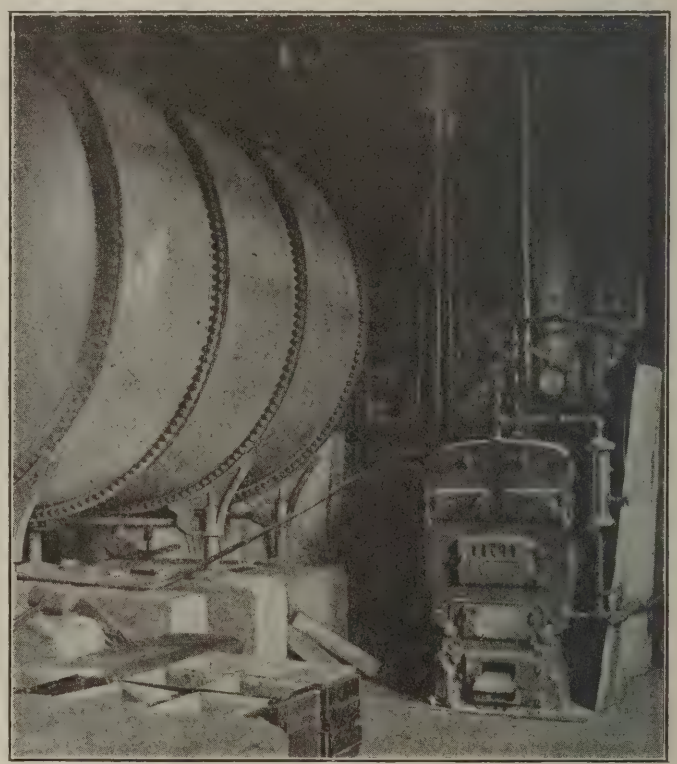
Contrary to the samewhat prevalent idea that electric car lighting is a comparatively simple matter, the fact remains that there is a mass of detail connected with the design, construction, operation and maintenance of such equipment. It might be well to call attention to the handbook on electric car-lighting equipment, compiled and published by the Association of Railway Electrical Engineers in 1918, which contains a wealth of detailed information for the purchaser, the operator and the maintainer.

The Cleveland Railways Company has taken out $10,110,000 insurance policy against "riot and civil commotion," paying a premium of $37,110. The policy covers 90 per cent of the company's line and is written by four western insurance companies.

WATER DISTILLATION ON THE LONG ISLAND

The illustration shows one corner of the car lighting battery house at the Long Island Railroad shops, Morris Park, L. I., in which is located the water distillation apparatus that supplies distilled water for use in all of the storage batteries on the road. In addition to the many cells of battery used for car lighting work there are over 1,000 cells of battery used on the multiple-unit cars of the electrified portion of the road. Storage batteries used in signal work as well as those used in sub-stations are also supplied with distilled water from this source. The tank shown at the left of the picture has its interior lined with white enamel. It has a capacity of 1,849 gallons which is ample to supply the needs for distilled water on the entire Long Island Railroad system.

The boiler used to generate the steam is of the ordinary dwelling house type and requires but very little



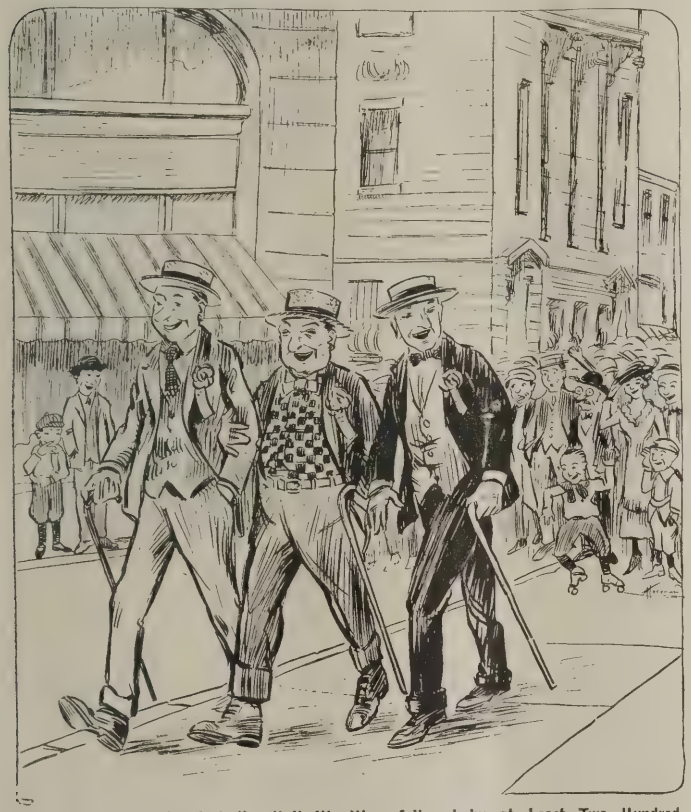
One Corner of the Battery House at the Morris Park Shops of the Long Island Railroad showing the apparatus for Distilling Water for use in Storage Batteries

attention. The safety valve is set so that the boiler carries approximately 2 lb. of steam. As fast as the steam is generated in the boiler it passes upward through a pipe and through the cold water jacket and the condensation is led into the tank. In order that the water in the boiler shall remain at the same level at all times an automatic water feed valve has been arranged. This valve is so connected with a float in an enclosed tank that whenever the water in the boiler falls below a certain point the float automatically opens the supply pipe and more water is fed into the boiler. In order that the same pressure may be applied to the surface of the water in this enclosed tank as is present in the boiler an additional pipe has been run from the boiler to the tank including the float valve. By this means the water is maintained at the same level in both boiler and valve tank at all times.

Trials and Troubles of a Car Lighting Man

Hinkey Dee Brings Jimmy Goat and Eddie Ram to the Convention of Car Lighting Experts

I NEVER talk about other people but what do you suppose Jimmy Goat asked me one day? The poor boob said, "Where were you yesterday, Hinkey, off sick?" I said, "Off sick, nothing! I was attending the Convention of Car Lighting Experts at Mill Creek, N. S." Then Jimmy said, "What's N. S., Hinkey?" I said, "Why, 'Nuff Sed,' you poor simp, what did you think it was? A nut sundae?" Gosh, some people is dum! Then he said, "What's a convention?" Now can you beat that? What's a convention! I said, "Why, Jimmy, I'm surprised at you, here comes Eddie Ram and I'll bet as dum as he is, he knows what a convention is." "Hello, Hinkey Dee," says Eddie. I says, says I, "Hello, Eddie, how's Eddie?" "Well, Hinkey," says Eddie, "I never felt better in me life." "Eddie,



By the Time We Reached the Hall We Were followed by at Least Two Hundred People

do you know what a convention is?" Eddie says, "Why sure I know what a convention is, for example, the telephone, the automobile, the airship, the ———." "Them's not conventions, them's inventions," says Jimmy. "No there not either," says Eddie. "Stop! Stop! Stop!" says I, "they're not what youse guys says them are at all. I guess your right, Jimmy, you and Eddie is both dum. Well, I guess I'll have to take the time and see if I can knock into youse fellers' heads what a convention is."

"Now you know that I know all about car lightin', not only on this road but every other road that there is. Do you suppose I'd know all about car lightin' on everybodies railroad if I didn't know what a convention is? That's what a convention is and the sooner you fellers know what a convention is the better because there's no use tryin' to tell yourself somethin' that ain't, when it is. Now I told youse fellers what a convention is and if you are willin' I'll take you fellers with me when I go to the next convention and show youse a thing or two." Jimmy and Eddie both said they'd like very much to attend a convention with me, because they'd be sure to know all about car lightin' if I'd take 'em to a convention once. So six weeks before the next convention I told Jimmy and Eddie to get themselves ready because you have to dress up in a businesslike manner to attend a convention because if you didn't nobody would learn nothin'. I told them that when I go to a convention I always look nice and attract attention the minute I walk in a place. So I wrote a letter to the president as follows:

"Dear Press,"

(You see I call him Press because I met him once before.)

"Me and two fellers, Jimmy Goat and Eddie Ram is going to the convention this here year. So be ready for a successful year and be sure to send me three badges instead of one.

Your old pal,
HINKEY DEE."

Soon after that I received a package with three big red silk signs in it, as follows:

CONVENTION OF
ELECTRICAL EXPERTS
MEMBER
MILL CREEK, N. S.

I gave one to Jimmy, one to Eddie and I kept one for myself and we agreed to meet at the railroad station.

The mornin' of the convention I was the first to arrive at the station and say, fellers, maybe I didn't look swell. You know I was an old timer and I knowed how to dress. I wore a brand new pair of yellow shoes and a bright greenish mixed suit, the trousers were a tight fit, high cut with a four-inch cuff, and I wore a new straw hat with a high crown, narrow rim and a green band to match me suit, I wore a Pickidilly collar with a green bow tie and a black and white check shirt. I says to meself, "Well, boys, you'll have to go some to look as nice as me."

I looked up the road and there come Jimmy and Eddie as spry as could be and, by gosh, they looked fine! I didn't think they'd have the brains to dress up so nice, of course they didn't look as nice as me, but they sure looked neat and businesslike. Eddie and Jimmy both had yellow shoes like me only a brighter yellow.

Eddie's trousers were too long for him and he had to roll 'em up three or four times and Jimmy's mother pressed his trousers the wrong way, putting the creases up the side seams, but they didn't look bad at all only at the bottom. By golly, but them fellers had swell vests on though, they bought 'em at the same place and were both the same color, "lavender" with large white pearl buttons.

Takin' everythin' into consideration we looked mighty nice. I took them across the street and bought us each a red rose for our button holes and a walkin' stick with a big hook on it so's we could carry it on our arms.

Well, sir, when we struck Mill Creek maybe we didn't attract *some* attention, as we walked from the station to

the convention hall. I says to Jimmy, says I, "Well, Jimmy, how do you like it?" Jimmy says, says he, "Well, sir, it's great!"

By the time we reached the hall we were followed by at least two hundred curious people. We could hear them sayin', "Who is it?" "Edison?" "No, I think it's Volta." "Maybe it's Ben Franklin?" "No, I think it's Bell."

Just as we entered the hall I give Jimmy and Eddie each a cigar with a big bright gold band on it and says, says I, "Now, boys, smoke this, throw out your chest, use your brains and head, and don't be afraid of nobody."

I took the lead into the meeting room, Jimmy followed and little Eddie came up strong in the rear. Just as we were going up the aisle, Jimmy must have got scared or somethin' because he walked so close behind me that he kicked my heel and down I went with Jimmy on top. Eddie was lookin' up in the air so high at somethin' he didn't notice us fall and he piled on top of Jimmy. Gosh, I was embarrassed. We got up and collected our canes and took a front seat. I said, "Now remember we have as much to say here as anybody has, and don't be afraid to have your say, because the more you say the further it goes. Make it sink in, that's it, make it sink in."

Then I introduced Jimmy Goat and Eddie Ram to all the other Electrical Experts and the convention commenced.

First the President called the Roll. We yelled "Hinkey Dee," "Jimmy Goat," "Eddie Ram" in order and made it strong. Then everybody started to laugh and some one said it must be the Zoo, but me, the Goat and the Ram couldn't see the joke, so we laughed too.

After roll call we talked about batteries, generators, regulators, belts, lamps, meters and eat sutra. When all of a sudden I heard a crash and looked around and found Eddie had fallen asleep and tumbled off the chair. Two fellows carried him up to the back of the hall and poured water all over his hands and feet and he come too all right, but gee he had a bump on his head as big as an onion. Yes, it was so big he had to cut a hole in his hat so he could wear it.

Then the President announced new business and what do you suppose Jimmy did, mind you it was his first convention and he stood up as straight as a die and said, "Mr. President, I move that we take all the batteries off all the cars and sell 'em." Eddie said, "I second the motion." "Hold on," said the President, "what are you driving at, the idea of taking all the batteries off all the cars. What do you mean? Explain yourself more fully." I jumped up and said, "Why, Mr. President, I don't understand this proposition of Jimmy Goat's—the idea of takin' all the batteries off the cars and sell 'em." Then Eddie jumped up and was about to say somethin' when the President yelled, "Sit down, sit down, how do you fellows expect Jimmy Goat to explain himself if you're going to be jumping up and down like a lot of jumping jacks? Why haven't you ever attended a convention before?" "See here, Mr. President," says Jimmy, "I know what I'm takin' about, I said I wanted to take all the batteries off all the cars and sell 'em simply because I can't see why you need batteries on a car anyway." Then everybody started to laugh and I got so mad at Jimmy, I didn't know what to do. I jumped up and said, "Why Jimmy Goat, you poor simp, if you are goin' to take all the batteries off the cars"—Then Eddie interrupted and said,—"Order, order," yelled the president. "Where do you fellows think you are at a ball game? Now I can't decide whether you fellows are crazy or what ails you. Let me hear from you one at a time, go on Hinkey Dee."

"Well," says I, "if this poor simp is goin' to take all the batteries off the cars, where is he goin' to get the lights from?" Then the President said, "Yes, Hinkey Dee, that's what I would like to know." Then Jimmy Goat said, "Well you flat heads if you'd wait long enough, I'll explain meself—Now first of all did you ever hear of perpetual motion?"—I said, "Yes I know all about every kind of motion." "Well sir," says Jimmy, "the idea is this. You see while the car is running on the road you get the lights from the generator." "Well," said the president, "I understand that but how about when the car stops where do you get the current from if you remove the batteries?" "Why," says Jimmy, "from the generator also, that's the point, you see between stations the train runs fast and stops

"Order, Order," yelled the President, "Where do you fellows think you are at—a ball game?"

suddenly at each station, the sudden stop causes the belt to slip and the generator keeps going although the car has stopped and before the generator can stop the train gets started again." Then I shook Jimmy by the hand and said, "By golly, Jimmy, your right, I never thought of that." Everybody laughed and the President looked at Jimmy, shook his head, smiled and said, "Jimmy, your a wizard. However, we'll let that part rest for another year." I could see that Jimmy had made a name for himself so I says to meself, "Now, Hinkey Dee, it's up to you to make good." So I stood up and said, "Mr. President, I have an idea, let's do away with all the batteries, generators and lamps and put a big head light like they have on engines at the end of each car. Put it above the door so it will shine the full length of the car." Eddie took a fit and two fellers had to hold him in his chair and sprinkle ice water on him. Then Eddie said, "Why that's impossible, where would you get the steam from to run it?" "Why," I says, "it don't run by steam in this case it runs by air." "Oh!" says Eddie, "I never thought of that." The President said, "Who makes the air?" I said, "Well, Mr. President, it's this way you have to have an air compressor on each car, this air compressor furnishes air to run the turbine, the turbine runs the generator to light the lamps." Then said Jimmy Goat,

"Who's going to run the air compressor?" I said, "Well, you can have an electric motor for that." Eddie said, "Well, where does the juice come from to run the motor?" I said, "Why from the generator that lights the light. The generator that lights the lamps runs the motor that drives the air compressor that furnishes air to run the motor that drives the air compressor that furnishes air to run the turbine that runs the generator." "Oh," says Jimmy Goat, "I see that now." "But," says Eddie Ram, "if the big head lamp is at one end of the car when the car runs in the opposite direction the lamp will shine in everybodies' eyes." "Well," says I, "each car will be equipped with a set of dark glasses or sun glasses, one for each passenger." Then everyone howled. The president tried to stop 'em from laughin' but couldn't. So he walked down the aisle and shook me by the hand sayin', "Hinkey Dee your a wonder and I want you to come to every convention we have and be sure to bring Jimmy Goat and Eddie Ram with you."

"Now," says the president, "I want you and Eddie and Jimmy to lead the parade today. Yes, you fellows have made the convention famous and I want you to lead the parade." "We'd be glad to," says I. So after the meeting me and Jimmy and Eddie marched down the middle of Main street leading the band and 500 electrical experts. I'll tell you boys it was great! Girls ran out from the sidewalk and showered us with flowers and yelled "Hurrah for Hinkey Dee, Jimmy Goat and Eddie Ram!"

After the parade we went into a restaurant to get something to eat. It was one of those one arm restaurants where you get what you want to eat out of a machine and take it to a table which is fastened to one arm of the chair you sit on. Jimmy went to get some buns and after he put his nickle in he got his finger caught in the machine, me and Eddie helped him pull it out and bandaged it up with paper napkins.

After we ate it was time to go for our train, so we hustled to the station and what do you suppose we found? The President and the whole five hundred members were there to see us off. They bid us farewell, told us to be sure to come next year and ended with three cheers for Hinkey Dee, the Electrical Expert.

During the Daylight Saving Season last year, the Edison Electric Illuminating Co. of Boston saved 4,420 long tons of coal because of the extra hour of daylight utilized by turning the clock one hour forward. The decrease in kilowatt-hours from this cause was 5,000,000, representing a loss of revenue of about $350,000.

The Total Annual Freight Bill of the lumber industry is estimated at about $215,000,000. Lumber and forest products furnish about 11 per cent of the total tonnage of the American railroads, or about 215,000,000 tons yearly, according to Interstate Commerce Commission statistics. This total is greater than the movement of all agricultural products and is exceeded only by the tonnage of general manufactures and mine products.

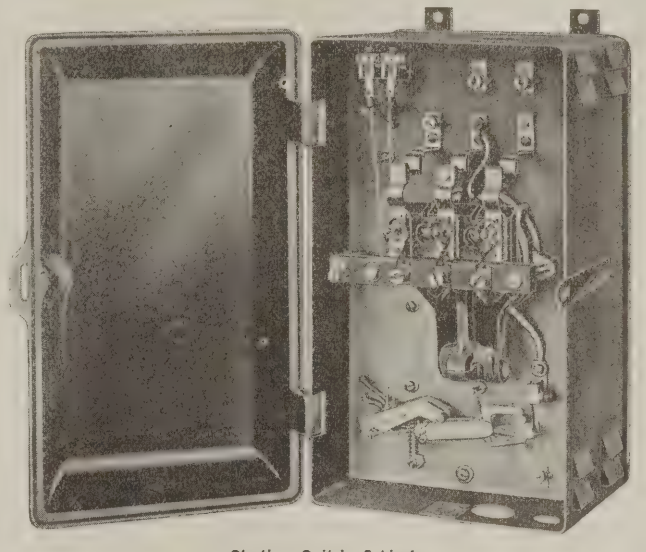
A Copper Alloy said to have the hardness of steel and of great tensile strength has been successfully experimented upon in France. It consists of 1 lb. each of chromium and aluminum, and adding 22 lb. of copper, 5 lb. of nickel and 4 lb. of zinc, with intervals of between half an hour and an hour between the successive additions to the fused mixture.

The A. C. Starting Switch

It is permissible to start induction motors up to and including 5 h.p., and in some localities up to and including 7½ h.p., by merely connecting the motor to the power circuit. Small induction motors can be started under these conditions without injury. In the past it has been customary to start these motors by simply closing a knife switch, or switch similar to a knife switch.

The man who wanted something better could buy a switch which would short circuit the fuses while the motor was starting, and then after the motor had come up to speed, the operator could make a second motion with a starting switch; insert the fuses in the motor circuit to be used while running.

A new device for this kind of work has just been developed by The Electric Controller & Manufacturing Company, of Cleveland, Ohio, to make the starting of these motors fool proof. It is known as the A. C. Starting Switch, and is operated by a push button. It is enclosed in a steel box as shown in the illustration, with conduit connection for all wires. A neat, compact push button arranged for conduit connection, is supplied for starting and stopping the motor.



Starting Switch Cabinet

Particular attention is called to the two wires extending the length of the slate on the left hand side. These wires give overload protection of the inverse time element type, both while the motor is starting and while it is running. The principle used is one entirely new in motor starting practice. These two wires are stretched, and the operating value of this overload protection is adjustable by changing the tension of the wire. If too much current is being taken by the motor, these wires will expand causing the small contact at the bottom to be open and this will in turn, de-energize the magnet coil and cut the motor off the power line. It is then necessary to push the start button before the motor can again be started.

This same principle is used in ammeters and gives an extremely accurate overload protection, at the same time giving inverse time element feature. There are no laminations used in any part of this A. C. Starting Switch. It is only necessary to push the start button to start the motor, and to push the stop button to stop it.

Welding of Bessemer and Open Hearth Steel

A Study of the Effect of Impurities and the Result of Electric Arc on Various Compositions

By E. Wanamaker and H. R. Pennington

STEEL is produced either by the Bessemer or the Open Hearth process. It is known as acid or basic steel, according to the character of the lining used in the Bessemer converter, or open hearth furnace. The basic lining has a fluxing action which assists in removing impurities such as sulphur or phosphorus, whereas in the acid lined furnaces the lining has little influence in the removal of impurities, consequently the raw material used should be of higher purity and grade to begin with. Among the elements which are added are: carbon, manganese, nickel, chromium, vanadium and tungsten. In ordinary boiler plate and structural shapes the controlling elements are carbon and manganese. These two elements are the only ones added. The carbon content determines the tensile strength, while the manganese is added to toughen the metal and prepare it for the mechanical treatment in the rolls. Boiler plate and shapes usually contain from 0.2 to 0.3 of 1 per cent of carbon and from 0.4 to 0.6 of 1 per cent of manganese.

After the steel has been given the desired composition it may be drawn from the converter into the ladles, and later poured into molds to make steel castings or it may be drawn from the converter into ingot molds and prepared for the rolls. If the steel is to be used for forgings, the ingot is sheared into conveniently shaped blocks or slabs called billets. These billets are then subjected to a final mechanical treatment in the drop forging machine. Plates and shapes are castings of steel which have been subjected to mechanical treatment in the rolls.

The heat treatment of steel is a broad subject, but it consists essentially of changing the crystalline structure of the steel without changing its chemical composition in order to get certain desirable properties. Neglecting the effect of heat treatment the physical properties of cast steel are determined by the kind and amount of the several impurities which are contained in the metal. Impurities of various combinations are used to get certain characteristics in the steel which seem to meet the requirements of the service demanded of the casting. While there is almost an unlimited number of combinations which may be obtained, the ordinary steel foundry uses a relatively limited number as compared to the possible combinations. Each element produces its characteristic effect on the metal, but the effect on the tensile strength, ductility, toughness and malleability is not necessarily proportional to the quantity of the added element over a very wide range.

It is more difficult to obtain sound steel castings than sound iron castings, since the shrinkage in steel is greater than in cast iron, and checking is therefore more liable to occur. Blow holes, or gas bubbles, enclosed in the body of the metal are especially liable to develop in mild steel castings.

*This is the eighth article on Electric Welding by E. Wanamaker, electrical engineer of the Rock Island Lines, and H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. Copyrighted 1919 by the Railway Electrical Engineer.

General Effects of Impurities

The following is a typical analysis of steel castings:

Element	Percentage
Carbon	0.35
Silicon	0.40
Manganese	0.80
Phosphorus	0.05
Sulphur	0.05

The properties ordinarily desired in steel are strength and ductility. Carbon is the most important strengthener. It will increase the strength of the steel with the least decrease in ductility.

Silicon causes brittleness if a high percentage is present in iron or steel. About the largest amount present in any commercial cast steel is ½ of 1 per cent.

Phosphorus is undesirable in any quantity in steel and is eliminated to as great an extent as possible. It causes "cold short" or brittleness.

Sulphur, like phosphorus, is undesirable in steel. It causes "hot short" or brittleness when the metal is red hot or hotter.

Manganese helps to remove the phosphorus and sulphur; it slags these two elements out of the metal. If manganese is present up to about 5 per cent it imparts desirable properties to steel, such as ductility and toughness. If present from 5 to 10 per cent it has an embrittling action. If present from 10 to 15 per cent it again produces a tough ductile metal, resisting abrasion, etc.

Nickel increases the tensile strength of steel without impairing the elasticity. Nickel steel does not rust as badly as steel without the nickel. The amount used varies from a small per cent up to 3.5 per cent.

Vanadium is similar to nickel in its effect on steel. It is usually present from 0.15 to 0.35 per cent.

Chromium is similar to manganese in its effect on steel. The amount of chromium varies according to the purpose for which the steel is to be used. Chromium has the property to a limited extent of acting as a self-hardener when used in correct amounts.

Tungsten is used in the manufacture of high-speed steels. Tungsten steel has the property of retaining its hardness at high temperatures.

Its composition is shown in the following table:

Element	Percentage
Carbon	0.40 to 2.19
Chromium or Manganese	.00 to 6.00
Tungsten or Molybdenum	3.44 to 24.00
Silicon	.21 to 3.00

In order to have a reasonably definite understanding of the structure of a steel casting, the history of the steel from the time it is originated in the converter until it becomes a cold casting should be investigated. Briefly, it may be stated that at the instant the point is reached in the conversion process at which all of the impurities have been removed, which are removable in practice, the metal in the converter contains ferrite, and traces of silicon, phosphorus and sulphur. The manganese, carbon and any other element which may be

desired is then added to the molten metal. The relationship or manner of combination of the elements contained in the metal between the time it exists in the ladle as molten metal and the state of a cooled casting goes through several changes. These changes, so far as the silicon, phosphorus and sulphur are concerned, may be neglected, since the rate of cooling has practically no effect upon the relationship.

If the metal is suddenly cooled from a point within the temperature range in which any of these changes take place, the combination of the elements existing at the time the cooling occurred would continue to exist. In other words, the normal cooling process may be stopped at any stage, and a different structure obtained at each point with a corresponding difference in physical characteristics of the metal. The heat treatment of cast steel amounts simply to a reversal of the changes outlined above; that is, raising the temperature of the casting until the desired structure is produced, then fixing it at that point.

The Weldability of Steel Containing Impurities

Little is known at the present time regarding the weldability of steel containing the impurities given above when present in their usual amounts when the electric arc welding process is used. It is known, however, that steel containing 0.5 per cent or more of carbon is subject to "burning" at much lower temperatures than low carbon steels. This fact can readily be observed in arc welding practice, the tendency being toward "burnt" metal in the weld. The observations which have been made up to the present time seem to indicate that the tendency toward "burning" shown in steels of comparatively high carbon content is the only considerable effect which is produced on the weldability by the presence of any of the impurities in their usual amounts.

The intelligent solution of welding problems in cast steel, as far as the metallurgical part is concerned, begins with a study of the casting to determine its nature and its characteristics. The welding process amounts simply to the addition of a certain amount of cast steel of a given composition so that a knowledge of the behavior of the metal of the casting as well as of the metal to be added when subjected to the temperature of the arc flame permits us to predetermine accurately what the nature of the complete job may be.

The chemical analyses that have been made of the metal deposited in the weld, using a bare electrode, show that most of the carbon and manganese is burned out in traversing the arc. However, by the use of coated electrodes to exclude the air from the metal while in a molten state, thus preventing oxidation and the loss of certain constituent parts during the execution of the weld, it is possible to deposit metal of a composition approximately equal to that of the part being welded.

Steel Forgings and Welding of Same

Forgings are simply castings of steel which have been subjected to mechanical treatment under the hammer. This process creates compressive strains, and as the pressure is relieved at once the elasticity of the metal causes it to recover somewhat from the effect. The result of the treatment is, therefore, superficial. Hammering is comparatively a slow process of reduction, but results in a better and more uniform working of the crystals which is the chief reason for the superiority of hammered over rolled metal. In regard to other working conditions concerning the hammering process perhaps the most important is the extra control over the operation and over the temperature at which the work is finished. These things can be exercised according to the discretion of the expert forger.

Drop forgings are directly comparable with steel castings except that they are superior in quality on account of the beneficial effect produced by working. There is a large variety of articles, such as parts of machinery, etc., which are formed by this means. The process consists essentially in placing a piece of heated metal between two dies which are made in the desired form of the finished article. The metal is then squeezed into these dies until it has assumed the proper shape. Sometimes more than one set of dies are required to complete the finished article.

Aside from the correction of small flaws before the forging leaves the forge shop, the principal application of the arc welding process is in the welding of worn and broken parts. The metallurgical problems involved in the welding of forgings are the same as those in the welding of cast steel so far as the character of the metal in the weld is concerned.

In forgings, however, the product has passed through a process of mechanical treatment which improves its quality for certain purposes beyond that of cast steel. The result of this mechanical treatment is greater compactness of the structure with a resultant increase in toughness. Therefore, the welded piece will consist of two grades of metal; the original metal which has received mechanical treatment and the metal added by the welding process which has not received mechanical treatment. In general, the metal added by the welding process will always have the characteristics of cast steel and the original unmelted part will always have the properties of mechanically treated metal. The metal in the weld may be hard or soft, of high or low tensile strength, but it will never have the toughness to resist the tendency to crack in bending to the same degree as the mechanically treated metal.

Up to the present time no cast steel has been produced which has all of the properties to the same degree as are found in any given piece of forged or rolled metal. This limitation of any welding process in which steel is melted should never be lost sight of in welding practice.

The Effect of Welding Steel Plates and Shapes

The application of the arc welding process on steel plates and shapes which are produced by the reduction of steel ingots in rolls is similar in every way to its application to steel forgings. This is due, of course, to the fact that plates, structural shapes, etc., belong to that class of products which have been subjected to mechanical treatment.

From the foregoing several general conclusions may be drawn:

(1) The tensile strength of the cast steel in the weld may be made less than, greater than, or equal to the tensile strength of the metal in the original section. This is true for commercial plate only.

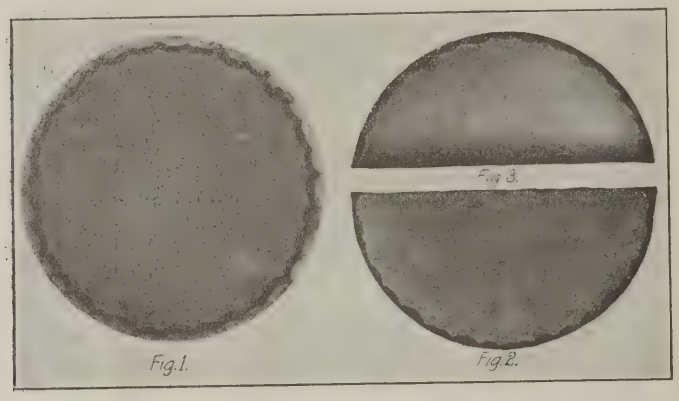
(2) The metal may be harder or softer than the metal in the original piece. The tensile strength of the metal in the weld will vary with the hardness. Burned metal is neglected in this conclusion.

(3) The elasticity of the metal in the weld will always be less than the elasticity of the metal in the original plate.

The effect of heat on the material being welded is governed largely by the rate of cooling and the carbon content. The rate of cooling will be determined by the mass of work, shape of the work, and by the manipu-

lation of the arc by the operator. The rate of cooling may be different in different parts of the same weld, with a corresponding difference in character of the metal in different sections. This, of course, is noticeable more in the higher carbon steels than in those which contain around 0.10 per cent of carbon.

When welding steel parts containing carbon above 0.10 per cent that have little or no factor of safety and which are subjected to alternate stresses the effect of the heat must be considered, even though the process is applied only to the extent of building up the part. In some cases, as with parts vital to the operation of machinery, such as piston rods, crank pins, and parts of similar importance, it is advisable to anneal after welding. An example of what may be expected from the effects of localized heat on such parts is shown in Fig. 1, which is the result of an investigation of a failed locomotive piston rod on which the cross-head fit had been built up by the metallic arc process. This photographic reproduction shows the area of added metal around the circumference. Between it and the larger section of metal in the rod is an area of metal, scallop shaped, effected by the heat. This illustrates the condition of



Sections of Piston Rod Built Up by Metallic Arc Showing Effect of Localized Heat and Result of Annealing

the metal in the rod at the time it failed. Measurements recorded for the average scleroscope hardness of the section shown in Fig. 1 are:

Added Metal	49
Dark Heat Effected Area	80
Metal in the Rod	50

The break resulted from small interior checks resulting in a detailed fracture which developed in the dark, heat effected area after the piston rod had been in service a few months.

Figs. 2 and 3 show sections taken directly opposite to the section shown in Fig. 1. These sections were heated to 1500 degrees F. and held at that temperature for three hours, following which the section shown in Fig. 2 was allowed to cool in the furnace, then polished and etched. The section shown in Fig. 3 was allowed to cool in the air, then polished and etched. These photographic reproductions show that the annealing process entirely eliminated the hardened area illustrated in Fig. 1.

Measurements recorded for the average scleroscope hardness of the section shown in Fig. 2 are:

Added Metal	38
Metal in the Rod	55

Measurements recorded for the average scleroscope hardness of the section shown in Fig. 3 are:

Added Metal	38
Metal in the Rod	57

The chemical requirements under which the piston rod was purchased were as follows:

Element	Percentage
Carbon—Not less than	0.38 or over 0.52
Manganese—Not less than	0.40 or over 0.60
Phosphorus—Not over	0.045
Sulphur—Not over	0.05

The weld was made with a bare mild steel electrode, which accounts for the difference in the degree of hardness between the added and the original material, as any carbon or manganese that may have been in the electrode material was burned out in passing through the arc. The same conditions are developed where other autogenous welding processes are used, and in some cases this heat effected zone may penetrate further than in the case of the electric welding process.

It is not the intention to convey the idea that it is necessary to anneal all such parts after they have been welded. This would not be consistent with everyday practice. As a matter of fact, most work of this class is done without annealing and with comparatively few failures. However, alloy steels, and especially heat treated steels, are sensitive to heat treatment; this fact must not be lost sight of.

In the welding of steel plates, shapes, etc., the conditions outlined above do not exist, at least with commercial plate up to ½ in. thick. This is due to the fact that the cooling curve is not so sharp; that is, the difference in temperature over a given area within the vicinity of the weld is much less than in the case of thick sections and heavy mass.

An intelligent analysis of the problems encountered in the service required of a given joint, together with an application of established welding methods, will leave no excuse for the failure of a joint which has been calculated to hold. The experienced welder does not guess; he knows what the joint will do. The success of the electric arc welding process, like any other manufacturing process, depends ultimately on the exercise of human skill and ingenuity. These factors are by far the most important to be considered. The apparatus itself is inamimate, but in skillful hands under the direction of an ingenious mind it will take a foremost place among the machines which produce an improved product at a lower cost.

The Weldability of Other Metals

Brass cannot be welded with the arc process. It will vaporize when the arc is formed from it. Bronze may be welded with the carbon arc and also with the metallic arc if the zinc is less than 3 per cent. Copper can be welded with the carbon arc; also with the metallic arc if the copper electrode is coated. Aluminum can be welded by the carbon arc but is not yet a commercial proposition.

Value of Goggles as a Protection from the Rays Produced by the Electric Arc.—The invisible actinic rays produced by the Electric Arc are the cause of "flash eyes." Ordinary glass is opaque to these rays. If the eyes are protected by goggles when working around commutators, breakers, or other apparatus that is liable to flash, danger from this source will be minimized.

Goggles are also necessary for the protection of the eyes from dust and flying particles when sanding or stoning commutators, blowing out machines and other apparatus, chipping concrete, etc.

IN DEFENSE OF THE AMPERE-HOUR METER

By Ernest Lunn
Chief Electrician Pullman Car Lines

The proper illumination of railway passenger cars is essential for the comfort of the traveling public which should be spared any disagreeable experience because of their inability to read on account of insufficient artificial light. Traveling at best, to the majority of people, is wearisome and everything possible should be done to put them at their ease, so far as illumination is concerned.

The author of an article elsewhere in this issue has given a brief history of car lighting, followed by some timely remarks about maintenance of electric lighting equipment. I note also that he hangs a danger signal on the ampere-hour meter method of battery charge control by implying that there is a possibility and even a probability that the battery and meter will get out of step. We have found that as a theory it is an interesting subject for discussion, but so far as having any practical significance is concerned, there is not much to it. Neither have we found that the present type of meter requires special attention. In fact the meter needs less attention than any other part of the car lighting equipment.

With a charging rate established high enough to insure the battery being fully charged and yet not so high as to injure the plates and with a sufficient amount of charge in excess of the discharge to insure a fully charged battery when the meter stands at zero, under practically all conditions, there need be little fear that a battery in good condition and its meter will get out of step. The floating voltage of a fully charged battery is considerably higher than its open circuit voltage and if the cells are not fully charged when the meter indicates that such is the case, they will absorb a synchronizing current at reduced rates which will tend to put the meter and battery in step. We have found so few cases where the meter readings could not be relied upon that there is little need to insure against the few cases that might happen. We have instituted the practice of setting the meters once each month to show an additional discharge of about the capacity of the battery, on the sound theory that twelve insurance charges a year will not do the plates any harm and will correct unevenness should there be any. It is sufficient to say that of the 6,000 odd meters which we have in service, only a very small percentage do not function properly. When a meter is inoperative, the fact is noticeable and repairs can be made quickly and easily before serious trouble results.

Aside from the value of the meter as a means for controlling the amount of charge to a battery it has another use to which many attach considerable importance and that is to indicate the state of charge of the battery. An electrician inspecting the equipment upon arrival takes note of the meter readings and is able to judge whether the equipment had been working properly on the trip just finished; also, without going to any further trouble he can form an opinion as to whether the battery has sufficient charge in it to insure proper lighting of the car up to the time the axle generator becomes operative. Our yard electricians, as well as inspectors and supervisors insist that the meters furnish information which is too valuable to be without.

It is not my purpose to advocate the use of any particular type of equipment or system of regulation for any railroad other than the Pullman Car Lines. Conditions under which equipment must operate on any particular railroad must be understood and if results are not as they should be the trouble must be analyzed and a remedy applied which fits the case best. One road seems to have found a solution for the trouble and has kindly given its experience so that others may profit by what it has learned. I am reminded of a saying of Josh Billings that "your own experience costs you one hundred cents on the dollar but you can get it from others for half price." Mr. Wanamaker is not even charging us that much.

*Abstract of reply to a paper on Railway Train Lighting, by E. Wanamaker, Electrical Engineer, Chicago, Rock Island & Pacific, at Opening meeting of the Western Railway Club, Chicago, on September 15.

WAR MEMORIAL SCHOLARSHIPS AWARDED

The awards of the four annual War Memorial Scholarships of five hundred dollars each, established by the Westinghouse Electric & Manufacturing Company, have just been announced. These awards were made by competitive examinations, and the following men were successful:

Herbert S. Pahren, Cincinnati, Ohio, employed as order clerk in the Cincinnati office of the Westinghouse

Herbert S. Pahren Arthur Marthens

company and a graduate of the Hughes High School, has selected for his scholarship a technical engineering course at the University of Wisconsin.

Arthur Marthens, of East Pittsburgh, Pa., began work as a messenger boy before completing his studies in the Turtle Creek schools. Mr. Marthens, while working in the cost department, prepared himself in the Casino Technical Night School to enter college. He has chosen a course in electrical engineering at the Carnegie institute of Technology.

Paul O. Langguth, a graduate of the Wilkinsburg High School and employed as draftsman in the engineering department at East Pittsburgh, has selected as his award an electrical engineering course at the University of Pittsburgh.

Andrew P. Lesniak, a graduate of the Union High School, Turtle Creek, Pa., and employed in the Production Department at East Pittsburgh, has selected a course in mechanical engineering at the University of Pittsburgh.

Two classes of scholarships are provided:

(a) For sons of employes of the company or its

subsidiaries who have been employed for five years or longer.

(b) For employes of the company and its subsidiaries who have been continuously employed for at least two years and who shall not, on September 1, have exceeded the age of 23. Not more than two class b scholarships will be awarded in any year.

Each scholarship carries with it an annual payment of five hundred dollars for a period not to exceed four years, the payment to be applied toward an engineering education in any technical school or college selected by the successful candidate with the approval of the scholarship committee.

These scholarships have been established as a memorial to those employees of the company and its subsidiaries who entered the service of their country

Paul O. Langguth Andrew Lesniak

during the war. Four awards will be made each year, so that after three years sixteen of these scholarships will be maintained in the best technical schools of the United States.

RULES FOR ELECTRICAL WORKERS IN WAGE AGREEMENT

The Railroad Administration on October 20 entered into an agreement with the shop employees covering wages and working conditions. Following the general rules covering all trades were special rules for each craft, those for electrical workers being as follows:

Qualifications.—Rule 139. Any man who has served an apprenticeship or who has had four years' practical experience in electrical work and is competent to execute same to a successful conclusion will be rated as an electrical worker. An electrician will not necessarily be an armature winder.

Classification of Electricians.—Rule 140. Electricians' work shall consist of repairing, rebuilding, installing, inspecting and maintaining the electric wiring of generators, switchboards, motors and control, rheostats and control, static and rotary transformers, motor generators, electric headlights and headlight generators, electric welding machines, storage batteries, and axle lighting equipment; winding armatures, fields, magnet coils, rotors, transformers, and starting compensators. Inside wiring in shops and on steam and electric locomotives, passenger train and motor cars; include cable splicers, wiremen, armature winders, electric crane operators for cranes of 40 ton capacity or over, and all other work properly recognized as electricians' work.

Classification of Linemen, Etc.—Rule 141. Linemen's work shall consist of building, repairing and maintaining pole lines and supports for service wires and cables, catenary and monorail conductors and feed wires, overhead and underground and all outside wiring in yards. Men employed as motor attendants, generator attendants and substation attendants who start, stop and oil and keep their equipment clean and change and adjust brushes for the proper running of their equipment, switchboard operators, coal in connection with loading and unloading vessels. Electric crane operators for cranes of less than 40-ton capacity.

Rule 142. Groundmen's work shall consist of assisting linemen in their duties when said work is performed on the ground.

Rule 143. Coal pier elevator operators and coal pier electric hoist operators in connection with loading and unloading vessels.

Apprentices Electrical Workers.—Rule 144. Include regular and helper apprentices in connection with electrical workers.

Electrical Worker Helpers.—Rule 145. Employes regularly assigned as helpers to assist electrical workers and apprentices, including electric lamp trimmers who do no mechanical work.

Rule 146. Fifty per cent of the apprentices may consist of electrical workers' helpers who have had two years continuous service at the point where employed. When assigned as helper apprentices, they must not be over 25 years of age, and shall serve three years, a minimum of 290 days each calendar year.

Rule 147. The following schedule for regular apprentices, showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as possible:

12 months—Inside wiring and electrical repairing,
6 months—Outside line work,
6 months—Locomotive headlight work,
6 months—Car lighting department,
6 months—Armature winding,
12 months—General electrical work.

Rule 148. Helped apprentices will receive the minimum helpers' rate for the first six months, with an increase of two cents per hour for every six months thereafter until their apprenticeship is completed. If within six months they show no ability to acquire the trade, they will be set back to helping and retain their former seniority as a helper. After completing their appreticeship, they shall receive the minimum rate paid for the work to which they are assigned, if retained in the service.

Rule 149. The following schedule for helper apprentice showing the division of time on the various classes of work, is designed as a guide and will be followed as closely as possible:

6 months—Inside wiring and electrical repairing,
6 months—Outside line work,
6 months—Locomotive headlight work,
6 months—Car lighting department,
6 months—Armature winding,
6 months—General electrical work.

Rule 150. Laborers or similar class of workmen shall not be permitted to do helpers' work as outlined in Rule 145 if regular electrical worker helpers are available.

Rule 151. Men engaged in the handling of storage batteries and mixing acid must be provided with acid-proof rubber gloves, hip boots and aprons.

Rule 152. Autogenous welders shall receive 5 cents per hour above the minimum rate paid electrical workers at point employed.

PRACTICAL STUNTS

A Protective Covering For Lead Cables

A recent issue of the *Electrical Review* states that a cement, clay and cheesecloth covering is probably the best and cheapest method of protecting cables in manholes from damage from an external source.

In adopting any covering it is important that it should radiate readily any heat which may be generated within the cable or protect the cable from heat caused by fire in the manhole or by burning up of adjacent cables, and at the same time furnish protection from mechanical injuries.

A covering which has proved satisfactory and inexpensive in comparison to other covers is made up as follows: First, wrap the cable with a layer of cheesecloth made up in lengths 4 in. wide. Second, on the top of this place a coating of cement and sand ½ to ⅝ in. in thickness. Third, over this coating wrap another strip of cheesecloth with a mixture of ordinary bank sand in which there is some loam mixed with cement in the proportion of 2 to 1 with very little water to the consistency of stiff mud. In winding this covering the cloth is pulled tight, thus forcing the grout to ooze out between the meshes of the cloth; this provides a finished outer surface for the cable. It is not considered advisable to give it a coating of neat cement, as such a coating provides too fine a covering and cracks will result.

It is evident that a cement coating of this thickness will protect perfectly the cable from any mechanical injury, and it is a fact that it will protect it from a very intense heat from without.

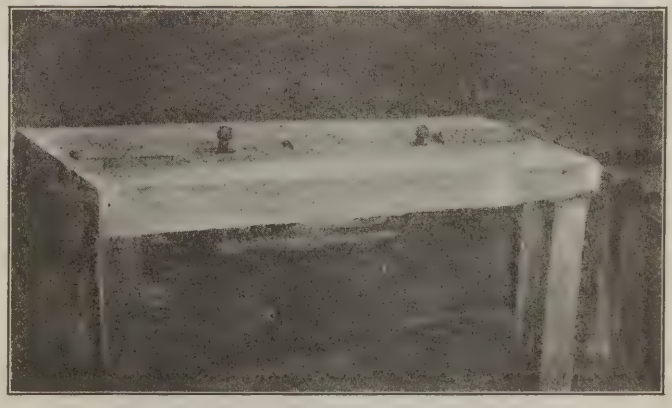
Setting an Automatic Switch Without a Voltmeter

By O. Grassman, Foreman Electrician, Pullman Car Lines Company, Pittsburgh, Pa.

Not long ago I had occasion to be riding a Pullman car when I did not have my voltmeter with me. I noted that the lights flashed brilliantly for a fraction of a second each time the automatic switch "kicked in," showing that closing the voltage of the switch was much too high. I decided, therefore, to set the switch and not having a voltmeter, hit upon the following plan. I obtained a lamp from one of the vestibule fixtures and connected it between the positive generator and the positive battery, then by means of the field arm, I varied the pressure on the field carbons until all of the resistance was in the field circuit, the generator voltage at this point being practically zero. As the automatic switch fell out the lamps flashed up to normal brilliancy, but as I lowered the arm the generator voltage "built up" and the lamps gradually became more dim until when the voltage of the generator was equal to that of the battery, the lamp was dark. As the voltage continued to "build up" the lamp again "showed signs of life" and the filament became quite brilliant before the switch "kicked in" this showed that there was considerable difference between the two voltages whereas there should only be two or three volts difference when the switch closes, so I again manipulated the field arm and screwed up on the automatic switch plunger until, after the dark period, the lamp filament became barely red when the switch "kicked in."

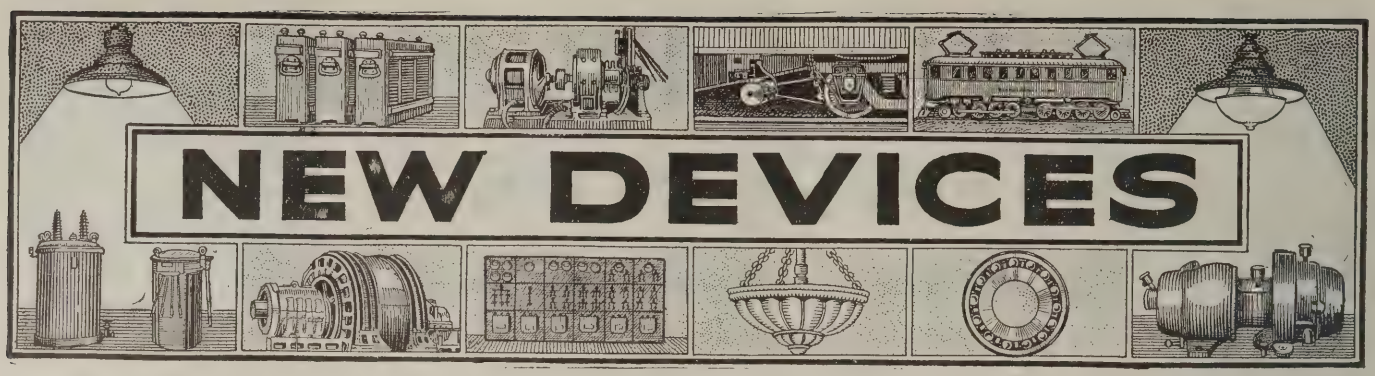
A Tank Washing Stunt

An original method for washing lead battery tanks is shown in the photograph. It consists simply of a wooden table under which a water pipe is lead and connected to two outlets as shown. These two outlets are spaced so that they are separated approximately the distance from the center of one tank to the center of the other in a tray containing two lead cells. By taking the tray containing the tanks to be washed and turning it upside down on the bench so that the tanks are directly over the outlets, the tanks are most effectively washed when the water is turned on. The force with which the



Battery Tanks Are Washed Quickly and Effectively by Twin Jets

water strikes the inside of the tanks is of course dependent upon the pressure, but the men in the battery house at Morris Park shops of the Long Island Railroad have found that this method of washing is perfectly satisfactory at that point where they have a water pressure of approximately 70 lb. The wooden cleats nailed to the top of the table furnish a support for the ends of the trays and allow the trays to be rocked backward and forward while the jets of water are being played upon the inside of the tanks.



A New Wire Reel Turntable

A device which is claimed will reduce the cost of time and labor in making cuts of wire and cable from reel lengths, is shown in the illustrations. This device is being placed on the market by the Reel Turntable Company, Chicago. It consists of a special cast iron base provided with a socket into which fits a

Base of Turntable and Revolving Element

special cast steel top or revolving table. This top plate is provided with cone shaped points for gripping the reel when it is placed on top of the turntable. The device weighs about 185 lb., it measures 14 in. across the top and 24 in. across the base. A reel sets 7½ to 8 in. from the floor when placed on top of the turntable. It will take any sized reel now on the market from 12 in. up, and will handle a load from

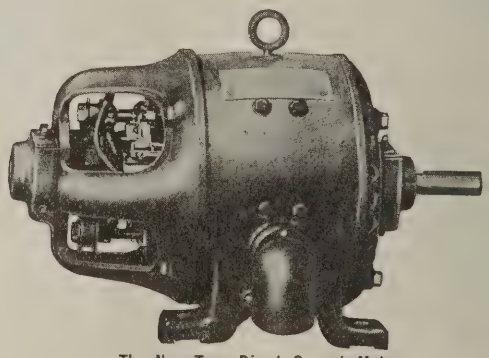
Reel and Turntable Ready For Use

3 to 4 tons. It is claimed that one man can measure out and cut cables in a few minutes with little effort. In placing a reel on the turntable it is necessary to have the reel so located that when it is finally in place it will be centered on the device and if heavy reels are being handled, blocks are necessary on the opposite side of the turntable to break the fall of the reel when it is turned on its side.

New Line of Direct-Current Motors

In the new line of commutating pole direct-current motors and generators just introduced by the Allis-Chalmers Manufacturing Company, the machines are not only rugged and compact, but many details which contribute to accessibility, reliability and safety have been thoroughly worked out. The line includes the following standard ratings: (1) Continuous rated (50 degrees C. Rise) motors, for applications where the power requirements are definitely known. (2) Normal rated (40 degrees C. Rise) general purpose motors. (3) Adjustable speed motors for continuous or intermittent service. (4) Cenerators and exciters.

For constant speed motors the ratings and speeds are the same as those of 60-cycle induction motors, and

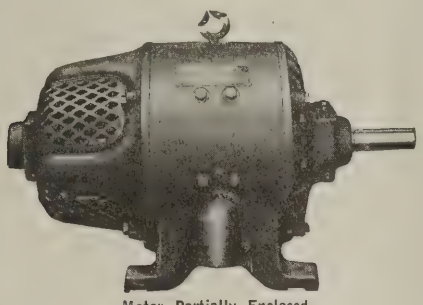


The New Type Direct Current Motor

they can thus be used interchangeably with induction motors for direct connected applications without changing the method of drive or the ratio of gearing. Adjustable speed motors, intended particularly for machine tool and similar applications, are provided for 2:1, 3:1, or 4:1 speed range. Generator speed also corresponds to those of induction motors, thus permitting the direct coupling of the machines to form motor-generator sets in various combinations. The line of ratings now complete covers motors from ½ to 50 H. P. and generators from ½ to 40 K. W., while larger sizes are under development.

The accessibility of the commutator is apparent from the photographs. Protecting grid covers can be provided for these openings in the front bearing bracket; they are readily attached without affecting the rating. Solid covers are used with completely enclosed motors, the rating being somewhat lower than open or semi-enclosed motors. All machines have ring oiling, dust-proof bearing, while the windings are treated to resist

oil and moisture. Conduit terminal boxes, regularly supplied, have removable covers, giving ready access to the terminals. Box-type brushholders are adjustable for tension and suitable for either direction of rotation. The field coils are wound on metal spools, which prevent any movement of the coils, and are protected by an outside layer of enameled wire. The armature core has the laminations riveted together, permitting the removal of the shaft without dismantling the core or commutator, while for ratings of 20 H. P. 850 R. P. M. and larger the core and commutator are



Motor Partially Enclosed

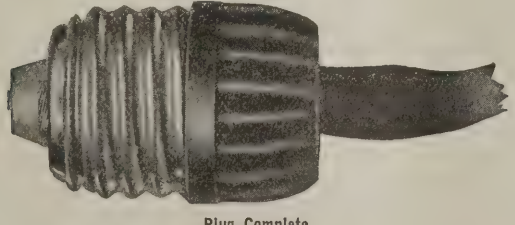
built on a sleeve, so that the shaft can be pressed out of the finished armature without disturbing the windings.

An important feature of the machine is the very thorough ventilating system. The air being drawn out by the fan mounted on the rear armature head; fresh cool air flows in through the liberal ventilating ducts and takes up the heat from the iron and windings. This heated air is forced out through openings in the periphery of the rear bearing bracket. With thorough ventilation the internal temperatures are kept low, greatly prolonging the life of the insulation.

This new line, designated as the Allis-Chalmers Type "E," is completely new throughout, no attempt having been made to redesign old apparatus or to employ parts from any previous machines. The motors are designed for belted as well as direct connected applications and are particularly suited to the exacting requirements of machine tool service.

A New Swivel Plug

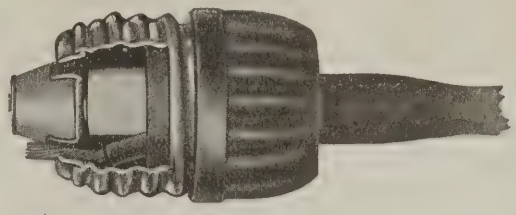
A new swivel attachment plug has been developed in the specialty department of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. The design of this new plug is such that several distinct advantages



Plug Complete

are provided. It is shipped completely assembled and need not be taken apart in order to wire. The work of attaching these plugs is further reduced because there are no binding screws to loosen. In fact no screws are used in the construction.

The plug consists of an inner and outer member which revolve on each other. The wires are connected to the inner member, while the outer member comprises the ordinary screw shell and a knurled head made of heat-proof molded insulation. In wiring two wires are stripped an equal length, about three-eighths of an inch; one is pushed into a center opening of the inner member and the other through any one of four concentric openings of the same member. By means of a soldering iron, one wire is sweated in the



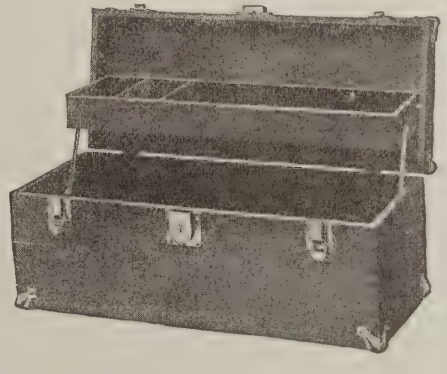
Plug With Side Cut Away

center opening, while the other, after being turned over into a groove on the inner member, is soldered to it.

After being attached to a cord there is no possibility of the parts becoming separated when being unscrewed from a socket. This is a very desirable feature when the plug is used under a small shade or where a good grip on the plug cannot be secured.

The Utility Tool Chest

Two new tool chests suitable for electricians' use have recently been brought out by the Union Tool Chest Company, Inc., Rochester, N. Y. The smaller of these chests is 16 in. long, 7⅞ in. wide and 7⅞ in. high. The larger of the two has the same width and height but is is 3 in. longer. The chests are made of kiln-dried oak, the frame joints being lock-cornered. The top of the covers and the bottom of the chests are rabbeted in, glued and nailed. The tray which is constructed in the same manner as the



A New Tool Chest for Electricians

chest is fitted with movable partitions. It is so fastened to the cover that it is automatically raised out of the way when the chest is opened, leaving contents of both tray and chest easy to reach. When closed the tray is flushed with the cover, holding contents in place in case chest should be overturned. A steel-cored leather handle capable of carrying of any weight which might be placed in the box, is supplied. Both chests may be had with imitation leather covering if desired, at a slightly increased cost.

General News Section

The Buda Company has opened branch offices in Buenos Aires, Brazil; London, England; and Paris, France.

The American Conduit Manufacturing Co., New Kensington, Pa., announces that its rigid conduit business has been leased to the General Electric Company and will continue to be operated at New Kensington by the Sprague Electric Works.

At Recent Meeting of the directors of the Norma Company of America, O. P. Wilson, who has been assistant general manager for several years, was elected vice-president of the company. W. M. Nones continues as president and treasurer in executive charge of the company's affairs.

Roller-Smith Company, 233 Broadway, New York City, announces the appointment of the General Machinery Co., 744-5 Brown-Marx building, Birmingham, Ala., as its agent in the states of Florida, Georgia, Alabama and Tennessee. The General Machinery Company will handle the Roller-Smith Company's line of instruments, circuit-breakers and meters in this territory.

The Western Electric Company has recently opened a new branch consisting of a sales office and warehouse at 334 East Bay street, Jacksonville, Fla. A full line of electrical supplies and specialties will be carried at this house. These will include pole line hardware, crossarms and other pole line construction material; all inside wiring materials; heating apparatus and all other electrical household requirements. The house is in charge of A. H. Ashford.

Samuel Rea, president of the Pennsylvania Railroad Company, made an address on "Our Railroad Problem" before the Savings Bank Section of the American Bankers' Association at St. Louis, Mo., on October 1. He outlined the plan of restoring the railroads as advocated by the Association of Railway Executives and went into a very thorough discussion of the Cummins bill, particularly in relation to the objectionable features from the standpoint of the railway executives.

The Western Electric Company has announced the appointment of F. H. Van Gorder as manager of the Newark store. Mr. Van Gorder came with the Western Electric Company in 1907 as a salesman connected with the company's Chicago house. In the spring of 1914 he was made sales manager of the Detroit store and in June, 1918, he took up the duties of power apparatus specialist at the company's New York office, which position he held until his present promotion to the managership of the Newark store.

The Trumbull Electric Manufacturing Company announces the appointment of M. L. Spaulding as manager of its Chicago office, 40 South Clinton Street. Mr. Spaulding was formerly a member of the Chicago office sales force, having left two years ago to accept a position as general sales manager of one of the large electrical supply jobbers in the Middle West. He has been in the electrical business for many years and is widely known among the trade of the Middle West.

The Schroeder Headlight & Generator Company, Evansville, Ind., changed its name to the Sunbeam Electric Manufacturing Company on September 27, 1919. This company's products have been marked and known as the Sunbeam turbo-generator and Sunbeam headlight for a number of years. As the Schroeder Headlight & Generator Company was reorganized and recapitalized since January, 1918, it was deemed advisable to change the name to the Sunbeam Electric Manufacturing Company to conform with the present conditions.

The American Malleable Castings Association reports that the insistent demand for malleable castings has been anticipated and that ample facilities have been provided for both present and future expansion of the industry. They state, however, that the present shortage of unskilled labor will not permit the use of this great capacity. Fully 200,000 tons of malleable capacity is idle today from the lack of necessary labor. Until the activities of other industries are curtailed or until there is a flow of immigration a large percentage of this capacity must remain idle continuously regardless of heavy unfilled orders.

The Government of Chile Has Decided to Electrify all railways under state control utilizing for this purpose the abundant water power available from falls of the western slopes of the Andes. The State railways, administered from Santiago, comprise about 2,300 miles projected or under construction; they include the Longitudinal Railway, the Arica-La Paz, the Copiapo and branches, the line to Coquimbo and branches, the Los Vilos line and the Central system. Dr. Juan Kuhn, a Chilean engineer is to visit the United States, England and France to make studies of electrification systems.

A. C. Alshul, in charge of the Milwaukee, Wis., district office of Joseph T. Ryerson & Son, Chicago, has been appointed branch manager of its new warehouse plant at Buffalo, N. Y., this company having recently bought the warehouse plant stock and good will of the Ferguson Steel & Iron Company, Buffalo. The property covered by the purchase at Buffalo includes a main building of about 100,000 sq. ft., divided into three spans, served by several bridge cranes, together with a large crane-served yard, office building, garage and storehouse. Plans are being made to carry out extensive improvements and for the enlargement of the property this coming winter. The Ryerson Company now has plants for warehouse service at Chicago, New York, Detroit, St. Louis and Buffalo.

The Bureau of War Risk Insurance has called attention to the fact that many soldiers, sailors and marines on leaving the service have through misunderstanding, misinformation or other causes permitted their insurance to lapse. A large proportion of these

men become transient at this time, with the result that the bureau has no way of reaching them by direct mail. Others have failed to furnish enough detailed information to identify their cases in the millions of records where scores have the same name. In order that these men and their families may be fully protected, conversion, reinstatement and information forms have been prepared for those who have dropped their insurance and it is recommended that two months' premiums on the amount of the insurance which the men wish to reinstate, be sent to the Bureau with the following information: First, full name (including first, middle and last name) and complete address; second, rank at the time of applying for insurance; third, army or navy organization at time of applying for insurance; fourth, army serial number, if in the army; fifth, number of insurance certificates if known. If this is done the handling of the matter can be greatly expedited. Those interested wishing further information should write the Bureau of War Risk Insurance, Treasury Department, Washington, D. C.

The Appleton Electric Company, Chicago, Ill., is erecting a new plant which it is claimed will give them double their present space and will result in increased production. The building is to be a four-story and basement structure and will cover an area of over 45,000 sq. ft. The main building will be ell shaped and a separate building will take care of the press room. This will require an additional 6,000 sq. ft. There will also be a separate power house. These buildings will provide 140,000 ft. of floor space and the entire plant is to be equipped with additional new and up-to-date machinery. The building of this large plant is indicative of the company's optimistic view of the future. The new plant is located at Pauline and Wellington streets, where a switch track from the Chicago & North Western Railroad furnishes excellent shipping facilities.

Proposed Electrification of Italian Railways

The London Times Trade Supplement reports that the Council of Ministers has approved a scheme, proposed by the Transport Minister, De Vito, for the electrification of the States railways. The bill provides for the exploitation of the national water power resources and their utilization for propulsion. The first program which limited the improvement to 2,000 Kilometers is now extended to 6,000 kilometers. This includes the two principal trunk lines across the Apennines, viz., the two "Direttissime," Genoa-Tortone and Bologna-Florence, eight mountain passes and the principal arteries of the railway system of the peninsular from Trient to Reggio, Calabria, or from Turin to Trieste. The bill provides for an expenditure of 800,000,000 lire spread over eight years. Other sums are provided for the acquisition of material and for the government's subsidies to the new plants. The Trentino alone can provide at least 1,000,000 horsepower, while the mountain basins of numerous rivers and torrents along the Alps and the Apennines can be transformed into artificial lakes.

Agreement Entered Into With the Shop Employees

For the first time the railroads of this country, through the Railroad Administration, have entered into a national agreement with the shop crafts as represented by the Railway Employees' Department of the American Federation of Labor and its affiliated organizations of the Mechanical Section and Divisions 1, 2 and 3 thereof, including the International Association of Machinists, International Brotherhood of Boilermakers, Iron Shipbuilders and Helpers of America, International Brotherhood of Blacksmiths and Helpers, Amalgamated Sheet Metal Workers' International Alliance, International Brotherhood of Electrical Workers and the Brotherhood of Railway Car Men of America.

The agreement includes 186 rules. The first section covers general rules applying to all trades and is followed by special rules for the machinists, boilermakers, blacksmiths, sheet metal workers, electrical workers and carmen. The wages have been raised to put them on an equal basis with wages paid to other railroad employees. The rate for mechanics who have been receiving 68 cents an hour has been increased four cents an hour; steel car workers and other mechanics in the car department who were receiving 63 cents an hour have been increased four cents an hour; other mechanics in the car department who were receiving 58 cents an hour will be increased nine cents an hour. In all cases these increases are effective as of May 1, 1919. Apprentices, helpers and other classes of workmen covered by Supplement 4 to General Order 27 have been increased four cents an hour, effective May 1, 1919, except for linemen and others, ground men, coal pier elevator operators and coal pier electric hoist operators, who are covered by special rules.

Electrification of Railways Contemplated in France

The French Ministry of Public Works is considering the question of adopting electric traction on French railways. A commission sent to this country to study railway electrification has recommended in a preliminary report the use of a 3000-volt direct-current system, such as that of the Chicago, Milwaukee & St. Paul railway.

A New Bulletin on Far Eastern Markets

The Bureau of Foreign and Domestic Commerce of the Department of Commerce, Washington, D. C., has recently issued a new bulletin entitled, "Far Eastern Markets for Railway Materials, Equipments and Supplies," prepared by Trade Commissioner Frank Rhea. The bulletin contains 339 pages, 46 illustrations and a map, and the author has discussed in detail the location and extent, traffic, profit, organization, equipment and purchasing methods of every important railway in the countries covered by the bulletin. Many valuable suggestions and recommendations have also been made. The territory covered includes China, Japan, Chosen (Korea) and the Philippine Islands. It is stated that in China especially there are and will continue to be exceptionally good opportunities for the sale of American locomotives, cars and all kinds of equipment, including American standard signaling equipment. It is felt that because of the urgent need for better transportation facilities the railway mileage in China is certain to be greatly increased and American manufacturers should be in an advantageous position to supply materials and rolling stock. A nominal sum is charged for the bulletin, and it may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Machinery Recovered From the Germans

The "Recuperation Service" and the "Restitution Service" of the French Ministry of Industrial Reconstitution in July made a report concerning the work

of identifying and returning to France of French machinery that had been carried off and made use of by the Germans. Through the end of March, the Restitution Service had shipped from Germany back to the departments in the north of France 1085 tons; at the end of May the total had gone up to 18,511 tons; and since that date, substantial shipments have been made from time to time. The shipments contained casks, glass, and a certain amount of industrial supplies in addition to machinery. There were also 200 carloads, with 2265 tons of machinery shipped from Germany to Alsace, and 2980 tons found and identified in Belgium, shipped back to the original factories in the north of France. The total reshipped into the devastated regions of the north and into Alsace up to the end of May was over 21,000. At that same date, over 15,000 tons of identified machinery was being dismounted and loaded in Germany, and 20,000 tons more had been identified in the Grand Duchy of Luxemburg and in Germany, concerning which the representatives of the French Ministry of Industrial Reconstitution were awaiting instructions from the French manufacturers concerned.

PERSONALS

WILLIAM K. FUZZELLE, electrician, first class, on the St. Louis-San Francisco Railway, at the West Shop, Springfield, Mo., has been transferred to Sherman, Texas.

PAUL V. LOUDON, electrician on the Buffalo, Rochester & Pittsburgh, has been promoted to the position of chief electrician with headquarters at Rikers, Pa.

A. H. GERALD, electrical inspector of the Pullman Car Lines at Chicago, has been promoted to the position of engineering assistant to the chief electrician at the same place.

PAUL SUTCLIFFE, advertising manager of the Edison Storage Battery Company, Orange, N. J., has been appointed manager of the industrial truck and tractor department of the same company. Mr. Sutcliffe has been with the Edison Storage Battery Company for the past five years.

E. CANTELO WHITE has been placed in charge of the lighting department which the Western Electric Company, New York, has recently added to its general sales organization. The new department has for its object the fostering of propaganda for better lighting in factories, offices, clubs and residences. Mr. White was born in 1880 and received his education at the Armour Institute of Technology in Chicago, graduating with the degree of mechanical engineer. His business career has been entirely devoted to the lighting industry; his experience during the past 15 years in the lighting field, where he has served both in the United States and Canada as a salesman and designer of lighting equipment, makes him suite dto his new position.

E. C. White

STUART D. DIMOND, whose appointment as chief electrician of the Minneapolis, St. Paul & Sault Ste. Marie was announced in the August issue of the *Railway Electrical Engineer,* was born at Winthrop, Minn., on January 2, 1891. He received his education at the New York Electrical School, graduating in April, 1912. From September of that year to February, 1914, he was repairman and later shop foreman at the Minneapolis branch of the Anderson Electric Car Company of Detroit. During the next year he was engaged as manager and part owner of a storage battery station. In August, 1915, he entered the service of the Minneapolis, St. Paul & Sault Ste. Marie at Duluth, Minn., where he was engaged in car lighting, construction and maintenance of electrical equipment until February, 1917. At that time he became electrical instructor in the Duluth public schools where he organized a course in general electricity for classes in the new junior high school system. He continued his work until June, 1919, when he was appointed chief electrician of the Minneapolis, St. Paul & Sault Ste. Marie to succeed J. R. Smith, who had been appointed signal supervisor of the same road.

TRADE PUBLICATIONS

A new catalogue of Chesapeake cranes has been compiled by the Chesapeake Iron Works, Baltimore, Md. The book contains 28 pages, 9 in. by 11½ in. The first half is devoted to descriptions and illustrations of the various parts of the cranes, while the last half contains full page illustrations of installations.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued circular No. 7149, covering the process of electric arc welding and the necessary apparatus required. A comparison is made of the different processes of welding and the advantages of electric arc welding are pointed out.

Trumbull Cheer for September contains an interesting discourse of the present day industrial conditions and their relation to the high cost of living. Pages 4 and 5 have the usual run of jokes, while the more serious side of things, particularly our future dealings with Germany, are brought out in several pages of acidified remarks under the head "Lest We Forget."

The Fafnir Bearing Company, New Britain, Conn., in the September issue of its house organ, "The Dragon," explains the operation of the Le Rhone Rotary Airplane Engine. A second article entitled "Farm Tractor Bearings," outlines some of the reasons why ball bearings are preferable in this modern farm implement.

The Sprague Electric Works of the General Electric Company has recently issued a Bulletin No. 47942 illustrating and describing a new line of panel boards which have been designed to meet the ever-increasing demand for devices that provide maximum safety to the operator. The branch circuit switches and main switches are distinctive features of these panel boards. They are simple in design, strong in construction, and positive in action. They have been specially designed for the safety panel board. Parts that are subject to wear are removable from the front of the panel and can be replaced without adjustment.

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THE FIRST RECONSTRUCTION YEAR

The year 1919 is destined to go down in history as one of the most unusual that the world has ever passed through. Being the first year after the close of the greatest of all wars it could not be expected that it would be other than abnormal, but it was quite impossible that any such conditions as we have gone through during the past twelve months could have been anticipated. Everything seems to be topsy-turvy. With the close of the war most people looked for a marked reduction in the cost of living, but looked in vain. Instead of going lower, prices began to climb; they have been at it ever since and are still going strong. No one seems to know where they will stop and the peculiar thing about it is the apathetic attitude of so many people who are paying the prices. Without doubt one of the big reasons for high prices is the payment of high wages in so many industries, particularly in those industries where organized labor is the dominating factor. Pressure has been brought to bear upon the manufacturers, and wages have been pushed upward to the point that would be hard to believe if the evidences were not to be seen on every side. On the other hand what has been a period of abundance for the wage earner has been one full of anxious problems for the average salaried man whose income has not kept pace with the swift rise in his expenses.

Coupled with higher wages comes the widespread and popular doctrine of shorter working hours. Reduced to the simplest terms this means today that there is a large element in the industrial world that seems to be pledged to do as little work as possible and to demand the most exorbitant remuneration for doing it. How long these conditions will prevail before sound common sense will dominate this nation of ours is something that is hard to foretell.

Considering the existing state of affairs, it is not surprising that no inventions of unusual merit have been brought out during the past year. Some improvements in existing devices have been made; one of the most important is that which has increased the sending speed of wireless stations to four hundred words per minute. The sending range of wireless stations has also been greatly increased. It is now possible, with the larger stations to span a distance of 12,500 miles, or half way around the earth.

Another change in the problem of communication by electricity is seen in the gradual substitution of automatic telephone systems for manually operated boards. Although this has not been done to any great extent thus far, it indicates that the automatic telephone is proving practical and it is only a matter of time when it will be the prevailing system.

Coming down to the application of electricity to the railroads, one thing that promises to receive a very large share of attention in many departments is the electric arc welding. It cannot be said that anything more has been learned about the art during the past year, but new uses have been found for it and there is little doubt but that the use of the electric arc welding process will prove among the most important economies that have been introduced upon the railroads. The money that is saved daily by the reclamation of worn and broken parts is almost unbelievable.

Looking ahead for a moment, it is not difficult to see that the turmoil and uncertainty of the labor market will be the determining factor in bringing about a great increase in the purchase of labor-saving machines. At present the problem of handling freight in large railroad terminals by various types of transfer equipments is being carefully studied. Most of such equipment will undoubtedly be electrically driven.

The big application of electricity to the railroads, that is, its use for motive power purposes, with one exception, has not made any notable progress during the year so far as increasing the amount of electrified mileage in this country is concerned. Many of the European countries, on the contrary, are planning very extensive electrified systems. The reason for this sudden rush to electric traction by the countries of Europe is obviously their great shortage of coal. This shortage together with the fact that they have an abundance of water power is more than enough to justify the extensive electric systems that have been planned. In America, however, the coal deposits are too large to cause any immediate anxiety about their exhaustion and hence what has been recently accomplished in this particular branch of electrical endeavor has been more in the nature of refinement in design of the electrical locomotive, with the single

exception of the completion this fall of another electrified section of the Chicago, Milwaukee & St. Paul road, which has been under construction for some time. Interesting information concerning the latest type of electric locomotives built for this road is given in another part of this issue.

ALTERNATING CURRENT WELDERS

During the discussion of the report of the welding committee which was presented at the last annual meeting of the Association of Railway Electrical Engineers, the subject of welding with a long arc was brought up. This in turn led to an argument concerning the relative merits of direct and alternating current welding machines. In one case that was cited, an operator was given one of each type of machine and told to use them both. After using them for a month he reported that both machines did good work, but that the alternating current machine had limitations, in that it was difficult to maintain an arc when building up the inner surface of a hole such as that in a valve gear link.

The discussion was dropped at this point, which was unfortunate for the reason that it would tend to give an uninitiated listener the impression that while the alternating current machine is a good one, the direct current machine is always better. As a matter of fact the alternating current machine has special merits of its own and its development should not be curtailed by a misunderstanding.

Alternating current welding, while it is a more recent development, has certainly shown excellent results when the work has been done by men familiar with the apparatus and there is no denying the fact that the alternating current machine possesses certain advantages which must be considered in comparing it with any other type of equipment.

THE COMING NUMBERS

There is something about the appearance of educational articles in a technical magazine that seems to possess the power of attraction to a much greater extent than the same instruction is ever able to exert when presented in the form of a text book. It may be because the information is offered in comparatively short installments, or it may be on account of its close relation with other articles in the same issue. Whatever it is there is no question as to its pulling power, for on many occasions long after a series of educational articles has been completed, inquiries have come to us asking if back numbers containing such series of articles could be had.

In view of the great interest shown in educational articles that have run in the *Railway Electrical Engineer* in the past we feel certain that our readers will be pleased to learn that during the coming year more articles of this kind will be published. For the benefit of young electricians who are anxious to improve their knowledge of alternating current, a series of articles is being prepared in which the subject is treated in the simplest possible manner that is consistent with a practical application of the information imparted. This series will run throughout the entire year of 1920 beginning with the January number.

In addition to the alternating current series a number of instructive articles on the subject of motor control will be presented. These are from the pen of Gordon Fox who furnished us with a very comprehensive series on induction motor windings about a year ago. Mr. Fox has had an extensive experience in the practical application of electricity and is well qualified to write on the subject of motor control.

DON'T GET BEHIND

Electrical men are beginning to realize that the problem of electrification of railroads is about 10 per cent an electrical and 90 per cent a railroad problem. When the subject was new, all matters of electrification were referred to electrical men. This is still largely true, but the electrical engineer of the future who will solve electrification problems will be essentially a railroad man.

Many foreign countries are taking steps toward the construction of much electrified mileage. Their need is much greater than ours because of excessive fuel costs, but our turn is coming and there will be an ever-increasing need of electric operation of trains in the United States.

Railroad electrical men are the logical men to take care of an electrification project and those who are ready to meet the situation will entrench themselves effectively in the railroad field. A method for solving such problems is laid out in detail in the October number of the *Railway Electrical Engineer*, together with a bibliography of practically all articles which have been written on the subject of electrification from the year 1908 up to the present time. It may profit you to save this for the next time when you may be called on to assist in making an investigation.

There is a resume of the work done in electrification during 1919 in this issue, a description one of the new locomotives of the Chicago, Milwaukee & St. Paul, a description of multiple unit equipment for an English railway and an article which is one of a series on electrification facts and factors. These are examples of articles which appear from time to time and if you are a railroad electrical man you should keep your knowledge up to date. Keep abreast of the field and don't get behind.

The Use of Electrical Energy on the Railroads

Application of Electricity to the Operation of Railroad Equipment is Being Greatly Extended

THE many applications of electrical machinery to railroad service were treated in five papers presented at the fifteenth annual electrical night of the New York Railroad Club. The program was a departure from the usual one in which electric traction has been the only topic under discussion. The papers presented touched on the use of electricity in all its ramifications.

There were 625 members and visitors present which was the largest attendance on record at any previous meeting except for a patriotic rally last year at which the attendance was about 750. Six papers were prepared, five of which were read. The subject of Electric Shop Power and Light was to have been covered by

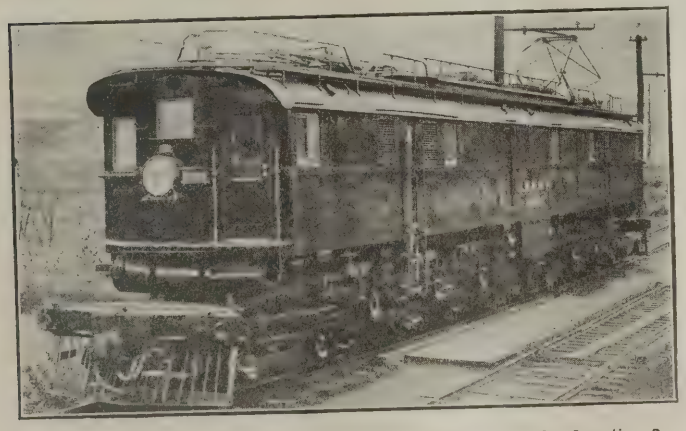


Fig. 1. One of the Ten Baldwin-Westinghouse Locomotives Built for Operation Over the Rocky Mountain Division of the Chicago, Milwaukee & St. Paul

J. L. Minick, foreman, electrical department, Pennsylvania Lines East, but he was unable to attend the meeting and his paper, prepared in the form of notes, was therefore not transcribed. An abstract of the other five papers follows:

Electrification of Steam Railroads in 1919

By Edwin B. Katte

CHIEF ENGINEER ELECTRIC TRACTION, NEW YORK CENTRAL

First of importance comes the electrical extension of the Chicago, Milwaukee & St. Paul from Othello to Seattle, a distance of 127 miles over the Cascade range of mountains. This work is practically complete and is in partial operation. Full service is delayed pending the delivery of the passenger locomotives. The system is 3,000 volt direct current with a double overhead working conductor or trolley, exactly the same as the existing and very successful 440 miles now in its third year of operation on the Rocky mountain and Missouri divisions.

The most interesting thing about this extension is two new types of passenger locomotives which are just ready for service. These locomotives are designed to operate a 950-ton train at 65 miles an hour on level track and to average 25 miles an hour over 18 miles of average 2.2 per cent grade and 20 miles of average 2 per cent grade. The Westinghouse Electric & Manufacturing Company will supply ten locomotives, each weighing 275 tons; the drive is through gears and quills by six twin motors of 700 h. p. each. The General Electric Company will supply five locomotives, each weighing 265 tons, and equipped with twelve bi-polar gearless motors of 270 h. p. each. One locomotive of each type has been completed and tested, and the balance of each order is well under way, so that soon after the new year, all 15 of these locomotives will be in service. The table shows the more important and complete data.

	Westinghouse	Electric
Total weight	275 tons	265 tons
Weight on drivers	12-350 H. P.	220 tons
Number and horsepower of motors	12-350 H. P.	12-270 H. P.
Total H. P. one hour rating	4,200 H. P.	3,250 H. P.
Tractive effort, one hour rating	66,000 lb.	46,000 lb.

New Haven Passenger Locomotive

While describing passenger locomotives, I must mention the new electric locomotives of the New Haven which are designed to haul 900-ton trains in express service between New Haven and Pennsylvania Terminal, New York City, over the Hell Gate Bridge Connecting Railroad, operating either alternating current at 11,000 volt overhead trolley or direct current at 600 volts on the third rail. Each locomotive weighs 180 tons, of which 115 tons are on the drivers. The motor equipment consists of six twin motors of 170 h. p. normal rating each. The drive is through gears and quills The total one-hour rating of the motors is 2,000 h. p. and at this rating the tractive effort is 21,000 lb. The motor armatures are permanently connected in four groups of three in series. Several of these locomotives are now in successful operation.

Pennsylvania Freight Locomotive

A description of recent electric locomotives, be it ever so brief, would be incomplete without recalling that the engineers of the Pennsylvania and the Westinghouse Electric Company have developed and tested an electric freight locomotive weighing 250 tons for service over mountain grades.

This locomotive, known as No. 3931, was tried out in June, 1917, and after the usual test track trials was put in regular freight service between Philadelphia and Paoli, where to date it has traveled about 5,000 miles. The electric equipment is designed to operate on 11,000 volts with single-phase current, taken from an

overhead trolley wire. At each end of the locomotive there are a pair of motors, each driving a jack shaft, the power being transmitted through springs and side rods to a set of three driving axles. The combined one-hour rating of the motors is 4,800 h. p. and at this rating the tractive effort is 87,200 lb. The maximum speed is 20.6 miles per hour.

Fig. 2. One of the 180-Ton Baldwin-Westinghouse Locomotives Built for the New York, New Haven & Hartford

Electrification of the Metropolitan Railway—

Not only in this country have things been happening electrically on steam railroads during the past year, but also in other countries, notably Australia. The electrification of the Metropolitan Railway System of Melbourne was put in service last May.

In 1908, C. H. Merz, the distinguished English authority on electric railroading, first reported on the electrification of the Melbourne Suburban Section of the Victorian Railway System. Proposals were received in 1912, based upon a single-phase 11,000 volt alternating current system, and other proposals upon the 1,500 volt direct current system. Under both methods the propulsion current was to be collected from an overhead catenary trolley supported by steel masts or bridges. It is reported that the single-phase scheme would cost 23 per cent more than the direct current, and it was estimated that the single-phase system would cost 21.7 per cent more in annual operation. Hence, the adoption of high voltage direct current. The delay in completing this work is attributed to war conditions.

The service is entirely suburban and the longest individual line extends a distance of 26 miles from the terminal. Trains running beyond the electric zone are drawn by steam locomotives. Multiple unit cars are used and they are of the compartment type with cross seats and wide side doors, following the usual English practice. The installation includes a large modern power station with two boiler rooms, set at right angles to the turbine room, much like the Fisk Street station of the Chicago Edison Company. The ultimate capacity of the turbine room is six 12,000 h. p. generators. This generating station is regarded as the nucleus of a scheme that will make available cheap electrical energy for future industrial development throughout the state of Victoria.

The electric power is transmitted at 20,000 volts. The transmission system is part underground cables and part aerial carried on the steel masts of the trolley system. There are 15 substations in the complete electrification scheme. Of these, seven are now in operation. The substations are in unit form and contain static transformers and rotary converters to change the transmission current from 20,000 volts, three-phase,

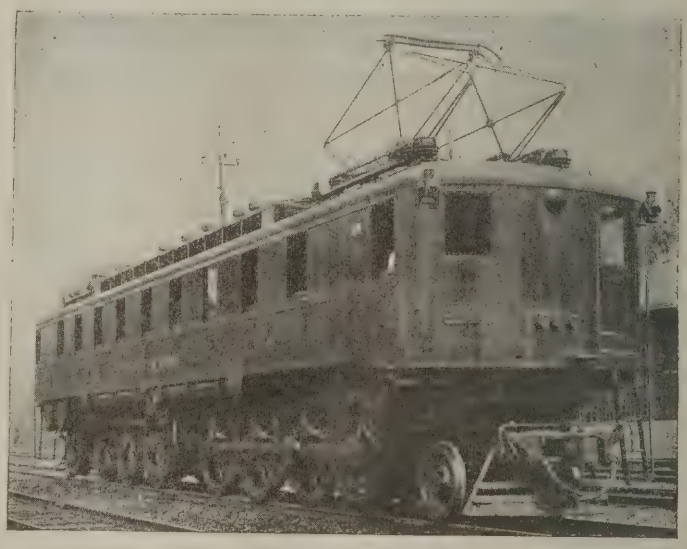


Fig. 3. A 250-Ton Baldwin-Westinghouse Locomotive Built for the Pennsylvania Railroad

25 cycles, to the working current of 1,500 volts direct current on the trolley wire.

Electric Automechanical Freight Handling

By Zenas W. Carter

Secretary-Treasurer, The Material Handling Machinery Manufacturers' Association

The railroads are to go back into private hands. The first problem executives and managing heads of all departments of railroading must face and work to solve is that of costs; both cost for materials and costs for manual service. The second problem is labor shortage; the third problem is lack of equipment; the fourth problem is condition of equipment; and last, but not least, is "attitude and productiveness of the entire personnel from the section hand to the directing chief."

Unfortunately, under government ownership and especially on account of the war reaction which is influencing men so strangely, there has been little serious attempt on the part of the operating and working forces to keep down costs. Further, man-power shortage is the natural result of the war. This same cause may be given as the reason for lack of railroad equipment and condition of equipment. Depreciation in productiveness is partly psychological and partly the result of the sudden increase in the distribution and rotation of money among the masses. Rotation of money tends to develop a sense of luxuriousness which directly results in a slacking of effort.

Knowing the problem and the factors of the problem is half the solution, however, and the real work for the railroad executive is the application of methods which will change the factors into a co-ordinated unit. It is possible therefore to visualize electric automechanical freight handling as a very important method which may be used to change the factors of high costs, labor shortage, lack of equipment, etc. We may even conceive that used thus, electricity may be the collodial to improve both the attitude of the individual toward his labor and to increase his productiveness. To visualize this it is only necessary to consider the changes electricity has already made in our daily life and to make the application specific as it relates to the use of electricity in new ways in railroad progress, it is only necessary to check over the present activity at some few points. For instance, few men in this country, even in the railroad lists, are familiar with the fact that the British Government is right now considering very seriously the elimination of every one of the 74 freight yards and stations in the city of London.

The Gattie System

The idea is to combine the entire interchange of all freight, both carload and l. c. l., into one immense central freight station and distributing point. This would be absolutely impossible without electricity as the all-powerful, infinitely flexible force with which to operate. When such an idea is even mentioned the average man simply must smile to himself and look to assure himself that the man who makes the statement is not a victim of shell shock. Nevertheless, this scheme, known as the "Gattie System" has received the consideration of the government and financial and business interests and is not at all an impractical proposition.

Mr. Gattie has worked out every detail from planning an immense depressed area of 30 acres to be known as the "Crypt" to the detail of the floor section and stalls on each of the planned nine stories of a gigantic fifteen-acre freight station. The "Crypt" will be used for all incoming trains and in making up trains to travel over all lines radiating in and out of London.

Of course the use of gondola cars in England—much smaller cars than in America—has made his plan workable, and he is to utilize the flexibility of electricity throughout to operate 196 powerful overhead traveling cranes, supplemented by a system of conveyors. The entire plant being planned to handle heavy loads in bulk. The cranes will lift uniform containers bodily from the platform of a car on the London & Northwestern say, and take it over and place it on the platform of a car on the Great Eastern. This will eliminate the present need for that car to pass through dozens of switches and suffer from four to ten days delay in its transfer across London.

In the handling of l. c. l. freight the containers are lifted bodily and taken to one of the four distributing floors. All goods, as they term freight in England, will then be handled from these central distributing floors to every part of that tremendous station by electrically operated conveying systems, escalators, chutes and electric trucks and trailers. Each lot goes from the central distributing floor directly to stalls where are particular containers for each railroad station or group of small stations. These containers filled with goods for one particular town will be lifted from the car platform by local cranes when the train reaches that town. The car platform then empty, may be at once utilized for a local container which has been previously loaded at that station just as we now load a box car with l. c. l. and the local traveling crane will place the container on the empty car platform and the train may then proceed toward its destination.

It will take just a little reflection to completely bring to your mind's view just what is necessary in the way of electric autochemical freight handling equipment to completely handle a system of this kind. Certain it is, however, that it is all possible through the use of electrically operated shuttle cars, electric traveling cranes, electrically operated conveyors or both the overhead trolley and the belt and apron and gravity types, and automatic elevators, and electric trucks and trailers.

The result of using such a system will be great economy, the release of the great spaces now used for yards and switch storage tracks and freight stations and it is

figured that the value of the 74 stations will be much greater than the entire cost of the proposed gigantic station. This would also solve much of the problem of reducing freight handling costs, labor shortage and equipment shortage. In addition the psychological effect upon groups of men operating machinery under sanitary and healthful conditions in all kinds of weather, and with a minimum of physical effort, is certain to be such as to change their very attitude toward this work, while the synchronization of the whole would automatically speed up the productivity of each worker. What is still more important it would tend to give both regularity of hours of toil and continuity of employment, with a resultant uplift in the mental calibre of the men employed which would be incalculable.

Freight Handling System for Cincinnati

Just to prove that electricity right here in the United States is going to help solve the coming problem of the railroad executives and managers and employees of the railroads in the United States, all the railroads of Cincinnati, Ohio, have made arrangements with a private operating company for the installation of a patented system of terminal operation. This company has almost completed all the installation of the electrically operated machinery necessary to carry out its method of handling l. c. l. freight at Cincinnati, and it is my opinion this or a similar system is going to revolutionize the transfer point interchange of l. c. l. freight all over the United States.

Starting from the results which will accrue at Cincinnati and working back to the principle of operation, the facts seem almost as revolutionary at first as the "Gattie System" will be in England. For instance, this Cincinnati plan to handle freight by automechanical methods, using electric and gas motor trucks and machines instead of steam coal, switch engines, engine and switch train crews, and switches, is estimated to release 56,000 freight cars previously used exclusively in "spotting," transfer, trip, or ferry service in the Cincinnati terminal territory. There is problem one, two, three and four met in a way which at first tends to stagger even our American imagination. Cost is reduced; equipment both released and saved from deterioration, and later shortage overcome.

But that is only part of the saving. The complete motorization of Cincinnati l. c. l. will save the railroads entering that city just about 300,000 switch out movements per year; and also will extend existing terminal facilities over 30 per cent and make a reduction of 25 cents per ton in handling cost. All at the insignificant cost to the railroads of approximately $150,000. Furthermore, to date over 140,000 tons of general classification merchandise freight have been moved without a single loss or damage claim resulting, and the current movement of all connecting line and substation freight has been greatly facilitated. Thus electricity functions tremendously as a force to help overcome these five problems of railroad management at Cincinnati.

The detail of the operation at Cincinnati is not a new untried scheme as it has been under practical every-day test for almost two years between main and sub-stations of the Big Four. The actual figures resulting from the tests were used in making the estimates for the complete plants now being installed. The system is a combination of motor trucks, overhead electric traveling cranes and uniform containers, with which will ultimately be combined many forms of mechanical handling machinery such as industrial electric trucks, stacking and tiering machines, portable conveyors, and other electrically operated devices which reduce physical labor and tend to improve the moral of the men who serve in the handling of freight.

It is the combination which is the essential element of saving as all of these devices and machines are now daily reducing manufacturing costs in most of our American industries, and most of them will soon be in service at terminal and transfer points handling ocean and river cargoes as well as freight.

The handling of l. c. l. interchange at Cincinnati is as follows, bearing in mind that at the present time the railroads are not making any attempt at store door delivery, although this also is undoubtedly going to be the outgrowth of the use of this system. At Cincinnati only railroad freight is being handled. The cars are spotted alongside the freight station in the usual manner. Doors are opened and hand trucks or electric trucks receive the goods in the usual manner. They are then conveyed to the uniform containers and packed into the container identically as you pack a freight car.

These containers are placed in rows in the freight station, each container being plainly marked for one of the seven railroads entering Cincinnati. The containers are wood and steel boxes, 17½ feet long, 8 feet wide, 7 feet high, and are usually loaded not to exceed four tons. The containers each have wide side doors and wide end doors so they may be easily loaded with miscellaneous freight of all kinds. Also each container (at least most of them) is fitted with large substantial casters so that it may be rolled across the station floor or rolled along the platform alongside a car. When the container is filled or loaded it is lifted by a traveling electric-crane, swung from its position and transported by the crane to the point where a motor truck chassis stands ready to receive the container as the complete body of the motor truck. Clamps are set and tightened, and the motor truck dashes off to the station of the railroad over which the goods in that particular container are routed.

At some stations the traveling crane delivers the container to the motor truck sidewise and at others the delivery to the chassis is endwise. In most cases where endwise delivery is made, and in cases where crane operation is not necessary on account of the few containers per day to be handled, the containers are set

on a type of skid, which is just high enough between its supports to permit the truck chassis to be backed underneath the container, and the lifting and lowering is then done through the use of electrically driven chain hoists. Where this latter method is in use, the skids are in bays extending into the station shed.

When the truck reaches the destined station, the traveling crane immediately relieves the chassis of the container and then places a return container on the chassis, effecting a minimum of delay for the motor truck. A central dispatcher handles the operation of all of the motor trucks, insuring their operation for a maximum percentage of the day.

The electric traveling crane of course carries the container with its load to the point nearest the spotted car of the connecting line and it is unloaded direct from the container into the car of the connecting line; or, if the goods in the container are for various small stations along the line, they are placed in proper cars in the usual manner, remaining in the container until cars are spotted for that particular freight division on which the station is located. It is entirely practicable to haul the containers about by means of a winch on an electric tractor truck although they are not yet equipped for movement by electric tractor.

Of course, it is but a step from the development of this system into an electrically operated unit for the complete system of freight service, including delivery and receipt of freight from store door, which will be a very simple step ahead—involving merely the use of the same type of trucks and containers for the door to door service as is now employed in the inter-railroad service. It is almost necessary for similar plans to be put into use throughout the country in order to meet the demands of the economic situation of costs, manual service need and equipment shortage.

Because of this engineers and railroad operatives are making exhaustive studies of these different machines and their co-ordination into handling systems. With its adoption will also come a fuller appreciation by the railroads of the value of all types of mechanical handling machinery. In our manufacturing plants, men are given the benefit of every conceivable type of machine or device which will save physical effort and conserve time and energy, or speed up production, but little use has been made of these electrically operated machines in freight and ocean cargo handling.

An automobile plant is equipped with numerous systems of conveyors, cranes, etc., all electrically operated. And in all large plants coal is handled by crane, belt conveyor or trolley with grab bucket, oftentimes without manual labor service from coal car to furnace grate bars, and even the ashes are automechanically carried to refuse piles.

Endless instances of the use of mechanical handling machines could be given, where savings have resulted sufficient to pay for equipment in one or two months after installation; and it is logical to believe that the very first moves on the part of the actual owners of the railroads after January 1, will be to purchase and install electric auto-mechanical handling machinery of many kinds.

Electric Trucks and Tractors in Railroad Service

By Frederick B. Fink

The Elwell-Parker Electric Co.

With the present labor shortage, high wages and shorter hours it becomes necessary for railroad officials to investigate ways and means for handling freight, baggage, materials in their shops, etc., at a less cost and in shorter time than is accomplished at present by the manual labor method. Man power is not entirely done away with by the adoption of electric trucks and tractors, but their usage will displace from six to ten men for each machine installed, depending upon conditions, and the services of these men can be employed in more profitable ways.

The use of electric trucks and tractors not only means a great saving in dollars and quicker service, but it makes the lot of the operator a more contented one. Thomas A. Edison has said, "It is my belief that the world's most immediate scientific need is inventions which will lighten the grinding toil of labor." The more machines brought forth to become identified with industry which can prove themselves labor saving, the more they will be the cause of enlarging the forces of employed labor, notwithstanding the belief by some classes of labor that these men-displacing units cause them to lose employment. This belief is wrong, as the men are placed in other classes or work. For example the automobile displaced many men, but it has given employment to hundreds of thousands of chauffeurs, a million men and women in automobile factories, branches, offices, service stations and parts and accessory manufacturers.

The electric truck, and tractor, are offered as labor saving machines and also as assistants to the remedy for the shortage of labor, but principally as a means of saving money on the cost per ton of material handled, and this is accomplished by means of their displacing men and handling more material in a shorter space of time. For the purpose of more clearly analyzing the handling of material in railroad service, it would be best to divide the subject into four sections, viz., piers, transfers, depots, shops and storehouses.

Piers

In the handling of freight on piers, the first object is to do so as cheaply as possible; the second is to handle the freight quickly, keeping the bulkhead clear for outbound freight and the inbound freight moved rapidly to the piles on the piers, ready for consignees' tracks.

Freight congestion at piers and freight terminals is caused by cramped quarters and lack of proper schedules. Old fashioned methods, hand trucks of the two-wheel type such as now used, were in use when the pyramids were built, as anyone interested sufficiently can see for himself by visiting the Metropolitan Museum of Art. A pier is not elastic and where a pier is handling from 5 to 10 times the freight it was designed to handle, it is not surprising that congestion should occur resulting in confusion and extensive delays. It is all very well to talk about longer piers and larger terminals, but these in many cases are physical, if not financial, impossibilities. We must work with what floor areas we have at present and by bringing efficient methods to bear upon the handling of merchandise, endeavor to relieve the pressure until such time as improved conditions are possible.

To do this properly, if the pier is of sufficient length to warrant the use of tractors, then tractors and trailers are advised. The height of the trailer should be governed by the height of the average tailboard from the floor of the bulkhead, on outbound freight, so that the freight may be placed directly on the trailer, pushed onto the scales and weighed. It is then ready to be made into a train for the tractor to pick up and pull onto the car float, where each trailer is dropped at the car door, to be pulled into the car, or pushed in by tractor if very heavy material such as machinery, etc., is on the trailer.

Objections to this method of unloading from tail board to trailers have been put forth because of the inability of the receiving clerk to give the exact weights to the different classifications, which he has to estimate if the consigner has failed to put the weight on the bill of lading. This, of course, applies only to mixed classifications on the same trailer and does not apply to solid loads made up of one classification.

To offset these objections some of the railroad companies unload to the platform of the bulkhead, where the freight is hand trucked to the scale and there hand trucked a few feet to waiting trailers on a level with the platform. Each trailer stands at a place bearing the corresponding number of the car, and when fully loaded the tractor picks it up and trails it to the car where the freight properly belongs and the checks are given either to the tractor operator or to the coupler of the trailers, who rides with the train.

Objections to the latter method have been raised, in that it causes an additional handling of the freight, thereby increasing the cost per ton for handling, but the users of this method claim accuracy for it, while with the tailboard to trailer method too much estimating has to be done.

Adherents of the tailboard or trailer method claim there is but little estimating to be done, but its greatest value is that by this method the bulkhead is kept clear, allowing the delivering street trucks to unload and get away quicker because the platform of the bulkhead is not congested. It is a noticeable fact that on these piers where hand trucks are still used the platforms are congested all day and at about 4 o'clock in the afternoon the freight is piled half way to the ceiling, while on the piers where electric trucks and tractors are used the freight is moved away as fast as it is unloaded and at 4 o'clock the platform is as clear as it has been at any hour during the day.

As a further indication of the saving to be effected by the use of electric trucks and tractors, at one pier on the Hudson river where the tonnage handled per day is comparatively small, an electric truck with platform, known as a "load carrying truck" to differentiate from a tractor, was placed to try out its possibilities for pier work. It was found, however, that the truck was not the proper unit, as the time consumed in loading and unloading was too great to warrant the investment. It was then decided to try it out using the truck as a tractor and five trailers were put in service with it. This is about one-tenth the proper number of trailers to a tractor and is mentioned here to indicate the handicap of the test. Notwithstanding the handicap and the unfamiliarity of the force with tractor and trailer operation, 119 tons were handled at a cost of .264 cent per ton.

To have moved this same tonnage by hand trucks, would have cost 56 cents per ton, showing a saving by the use of the tractor of .296 cent per ton. In spite of the handicap mentioned above the operation kept two doors of the bulkhead clear. We furthermore found in the experiment that when using hand trucks, the driver of the street vehicle would place the boxes or packages on the tailboard of his vehicle and wait for the freight handlers to unload it onto the platform, while there was no hesitancy on his part to place the boxes or packages on the trailer himself when it was backed up to the tailboard, thereby freeing at least one freight handler for other work.

Transfers

Here also seems to be a division of opinion, as to whether the tractor and trailer system or the load carrying low platform electric truck, is the most efficient and economical. Both systems of handling have their adherents, but with either method as compared to the use of hand trucks the handling is done quicker and with considerable saving in money. From figures received from transfers where load carrying trucks are used the conclusion can only be arrived at that while the initial investment is greater than that for tractors and trailers the cost per ton is less.

To illustrate this, one of the large transfers using a number of load-carrying trucks, handles about 1200 tons per day at a total cost per ton, including everything chargeable to the operation, of 61 cents per ton, and this with trucks that are now about nine years old with the higher cost of maintenance due to their age. In this operation, manual labor is reduced to a

minimum as the loaded truck runs into and to the end of the car where its load is removed from the low platform by hand, and vice versa when loading. In another large transfer, where only tractors and trailers are used, and where about 1200 tons average per day are handled, it is interesting to note that on November 7, 1918, 19 gangs of 5 men each with two-wheel hand trucks; 14 tractor gangs of 3 to a gang; 14 floaters and 41 packers, or 192 employees in all, were thought necessary to handle 1352 tons of miscellaneous freight, at a cost of .955 cent per ton. By proper supervision and rearrangement of the handling it was found that, after the wrinkles had been ironed out, 1221 tons could be handled by 4 gangs of 5 men each with two-wheel hand trucks; 11 tractor gangs of 3 men each; 13 floaters and 39 packers, or a total of 105 employees at a cost of .769 cent per ton, or a saving of .186 cent per ton over the cost without proper supervision.

It will be seen therefore that in two transfers handling about the same class of freight and about the same tonnage per day, a difference of .159 cent per ton is shown in favor of the load carrying truck over the tractor and trailer system. Handling 1200 tons per day, would amount to $190 per day or $57,000 per year, thereby proving the contention that the difference in initial cost is soon made up. Further, in the use of the tractor and trailer method, the tractor drops the loaded trailer at the car door, when it becomes necessary for man power to be used to push the trailer into the car and possibly to the end of the car over floors that often are none too smooth and very often wet, and when unloaded has to be used to push the trailer out onto the platform for the tractor to pick up. By the use of the man power in this operation the tractor becomes only partly a labor saving unit, which is wrong when units better adapted to the service are available.

However, in small transfer stations tractors are being used with good results, two of these small transfers reporting that in the handling of 300 tons each per day, each with one tractor, one transfer having 16 trailers and the second having 40 trailers—both tractors working under adverse conditions, as to cross-overs, platforms, etc.—the first showed a saving of six cents per ton, due to the small number of trailers used and the second a saving of 10 cents per ton. Both are showing a saving, but in addition, the receiving platforms are kept clear, something unknown before, and the entire operation is speeded up.

The belief that any one type of electrical truck or tractor is the proper unit is erroneous and there is an inclination toward the use of electric elevating platform truck for transfer work, as by its use castered platforms may be picked up with their load and deposited in the car at the point of stowage, the truck picking up an unloaded platform and returning it for a load, depositing it and immediately picking up a loaded platform which the laborers have loaded while the truck was in transit with its previous load. By this method the pushing of trailers into and out of cars is eliminated, as in the tractor and trailer system, and the objection to the load-carrying truck without the elevating platform of having the truck tied up so long for loading and unloading has been overcome.

Another type of electric truck which is a valuable adjunct on piers, in transfers and shops, is the crane truck of 2000 lb. capacity, used for handling heavy pieces of machinery and other heavy materials and in the case of piers or transfers, lifting that machinery or other heavy material onto the load-carrying trucks or onto trailers, as the case may be, thereby saving a great amount of labor and time.

Depots

The sight of electric trucks hauling baggage and mail in passenger terminals is a common one, but its importance can scarcely be enlarged upon, as while it is an established fact that the savings shown by these trucks are from 58 to 80 per cent over the old method of pulling the trucks by hand, there are some items which must be taken into consideration and on which it is impossible to place a value in dollars and cents; these are the relief to terminal congestion and the prompt despatch of trains resulting from avoidance of baggage detention. This also applies to express and mail haulage.

Shops and Storehouses

The electric truck, particularly the elevating platform type and the crane truck, or a combination of the two types, are of such value in the shops and storehouses that the saving is almost unbelievable, as the records submitted on 51 electric trucks in 14 shops show a saving in labor as high as 89 per cent, and that without the later types of trucks designed for use in shops and storehouses.

Records show that with the installation of one truck in the shops on one of the large eastern railroads, four men were displaced who were receiving 39 cents per hour which equals $3,744 per year. On the same railroad, in the shops located in another city, three trucks were installed, which displaced 11 men, who were receiving 42 cents an hour, or $11,088 per year.

In the shop of another well-known eastern road, an electric truck was installed for handling car seats to and from the upholstery department to the cars. This truck showed a saving of $3,024 a year, and that at the time when the labor the truck displaced was receiving but 24 cents per hour.

The shops of still another road in the east have in service four load-carrying trucks and one tractor and these have displaced 25 men with hand trucks, 8 horses or mules with drivers and the services of a switch engine for 2 hours a day; they show a saving over the former method of handling of $34,363 per year.

The electric crane truck of 2000 lb. capacity will be found to be a valuable unit in shops for the handling of pumps to and from the locomotive, as well as in the handling of heavy castings, etc., picking the material up, placing it on the platform of the truck, carrying it to its destination quickly and depositing it where wanted, saving a great deal of time and labor.

Electric Welding

By H. A. Currie

Assistant Electrical Engineer, New York Central

During the past three years numerous articles have been written describing the progress in the art of electric welding, covering the relative merits of machines, electrods, methods of welding, current values and so forth. These show the ever-increasing interest in the subject.

The keen interest displayed by the Emergency Fleet Corporation was reflected in the appointment of the well known welding committee composed of representatives of shipping men, engineers, the government, colleges and railroads. The wide publicity given the work of this committee has had much to do with the great interest taken by manufacturers, builders and railroads.

This paper will be devoted to a brief resume of the welding facilities and general character of work done in the motive power shops of the New York Central. One phase of welding that has had but little attention paid to it is the fundamentally important one of preparation. This will be emphasized in the present paper. Railroad shops are perhaps the largest users of arc welding machinery for repair purposes.

The facilities in New York Central shops consist both of D. C. and A. C. units of various makes. Depending on local requirements they are either portable or in a fixed location. Satisfactory results have been obtained from both types of equipment.

The welding facilities consist of the single operator type of machine suitably located throughout the buildings and so connected by bus lines that machines can be electrically connected to any outlet throughout the shops. This arrangement gives all the advantages of multiple operator machines with none of the disadvantages.

The saving in our locomotive shop since electric welding was installed can hardly be calculated and the additional mileage that is obtained from locomotives is remarkable. This is mainly due to the following:

A. Greater permanency of repairs.

B. Shorter periods in the shop, giving additional use of equipment.

C. Existing shop facilities permit taking care of a larger number of locomotives than originally expected. Shop congestion relieved.

D. The use of worn and broken parts which without electric welding would be thrown in the scrap pile.

E. The time required to make repairs is much less and requires fewer men.

F. A smaller quantity of spare parts carried in stock.

The following is a brief description of some of the work done on steam locomotives:

Flue and Fire Box Welding

The most important results are obtained by welding the boiler tubes to the back flue sheet. The average mileage between shopping an account of leaky flues on passenger locomotives was 100,000 miles. This has been raised to 200,000 miles with individual records of 275,000 miles. For freight this average has been raised from 45,000 to 100,000 miles. At the time of locomotive shortage this effect was of inestimable value.

Good results have bene obtained without the use of sand blast to prepare the tubes and sheets. The engine is either fired or an acetylene torch used to burn off the oil, after which the metal is cleaned off with a scraping tool. The ferrules are of course well seated and the tubes rolled back. The boiler is filled with water in order to cool the tubes, which having a much thinner cross section than the sheets, would overheat sufficiently to spoil the weld or burn the tube. The metal is then laid on, beginnign at the bottom of the bead and working to the top. Records show that the time to weld a Pacific type locomotive boiler complete is 12 hours.

A variety of repair work is readily accomplished in locomotive fireboxes such as the welding of crown sheet patches, side sheet cracks and the reinforcing and patching of mud rings. Smokebox studs are also welded on.

Side Frames, Couplers and Wheels

Cracked main members of side frames are retored and wearing parts built up and reinforced. Because of accessibility no special difficulties are encountered in this work. Formerly this work was chiefly done with oil welding and some acetylene and thermit work, but it was very much more expensive as the preparation required considerable effort and took a good deal of time.

Fifty per cent of the engines passing through the shops have worn and broken coupler parts and pockets. By welding an average saving of about $15 per coupler is made. It costs about $30 in material and labor to replace a coupler and only $4 to repair the average broken coupler. The scrap value is about $5.

Great success has resulted from various repairs to steel wheels and tires. Flat spots have been built up without removing the wheels from the locomotives, thus effecting a great saving in time and

money. Building up sharp flanges saves about 5/8 inch cut off the tread, which when followed through means about $30 for a pair of wheels, a great increase in tire life and reduction in shop costs.

Cylinders

The most interesting feature developed by arc welding was the accomplishment of cast iron welding. The difficulty in welding cast iron was that while the hot metal would weld into the casting, on cooling the strain would tear the welded portion away from the rest of the casting. Small studding was tried out with no success. Not until wrought iron studs, proportioned to the sectional strength of the casting, were used did any satisfactory welds

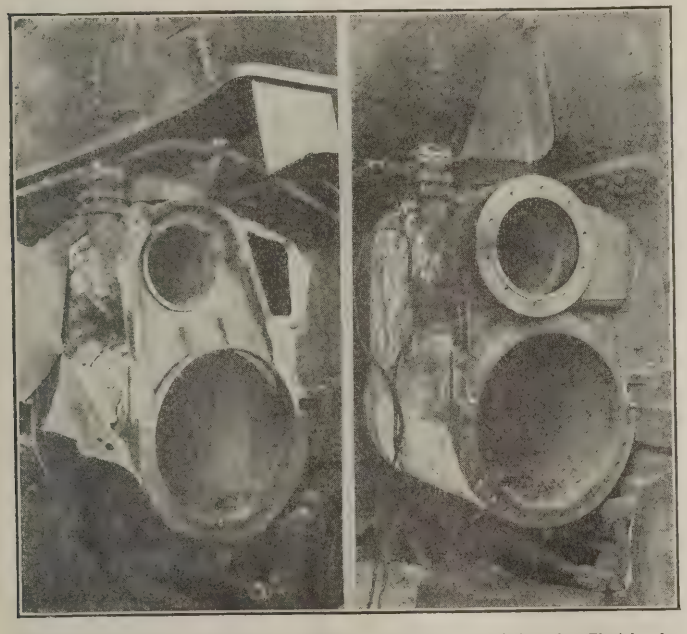


Fig. 4. Example of Repair Work Done on Locomotive Cylinders by Electric Arc Welding

turn out. Studding of this large size was looked upon with distrust as it was thought that the only weld was to the studding. This naturally meant that the original structure was considerably weakened due to the drilling. This, however, was not the case. The large studding was rigid enough to hold against the cooling strains and prevented the welds in the casting from pulling loose, thus adding the strength of all the welded portion to that of the studs. In most cases where external clearance will permit, sufficient reinforcing can be added to more than compensate for the metal removed in drilling for the studs.

Perhaps more skill is required for this class of welding, but with a properly prepared casting success is certain. A concrete case of the economy effected in welding a badly damaged cylinder on a Pacific type engine is as follows:

WELDED JOB

Cost of welding broken cylinder, labor and material	$125.00
Length of time out of service, 5 days at $20 a day	100.00
Scrap value of old cylinder (8,440 lb. at 2.09 lb.)	177.00
Total	$402.00

REPLACED CYLINDERS

Cost of new cylinder ready for locomotive	$1,000.00
Labor charge to replace it	150.00
Locomotive out of service 18 days at $20 a day	360.00
	$1,510.00
Less cost of welding	402.00
Total saving	$1,108.00

Some 25 locomotives have been repaired in this way at one shop alone.

Many axles are being reclaimed by building up the worn parts. These are tender and truck axles which are worn on the journals, wheel fits and collars. The saving is about $25 per tender axle and $20 for truck axles.

The range of parts that may be repaired or brought back to standard size by welding is continually expanding. Wearing surfaces on all motion links and other motion work, cross head guides, piston rod crosshead fits, valves and valve seats, air, steam, sand and other pipes, keys, pins and journal boxes have all been successfully welded.

A large saving is effected in welding broken parts of shop tools and machinery. During the war this was of untold value, as in some cases it was out of the question to get the broken part replaced.

Training of Operators

This is the most important feature of arc welding Success depends solely on the men doing the work. They must be instructed in the use of the arc, the type, size and composition of the electrode for various classes of work and the characteristics of the various machines they will be called upon to use. A properly equipped school for teaching these matters would be a valuable adjunct for every railroad. Manufacturers of equipment have recognized the importance of proper instruction and have equipped schools where men are taught free of charge.

Supervision

Co-ordinate with the actual welding is intelligent supervision. The scope of the supervisors should include preparation of the job for the welder and general oversight of the equipment in the shop.

Thus the duties of the inspector might be summarized in the following points:

1. To see that the work is properly prepared for the operator.
2. The machines and wiring are kept in good condition.
3. Proper electrodes are used.
4. To inspect the welds in process of application, and when finished.
5. To act as advisor and medium of interchange of welding practices from one shop to another.

In work such as flue welding and industrial processes which repeat the same operation, piece work rates may be fixed. For varying repair jobs this method cannot be used with justice either to the operator or the job.

Bare electrodes are used almost exclusively, even for A. C. welds. Whenever a new lot of electrodes is received it is good practice to make up test piece samples and subject them to careful tests and analysis.

The sizes of electrodes and uses to which they are put are shown in the table.

Size	Type of Work
1/8-in.	Flue welding.
3/32-in.	For all repair work, broken frames, cylinders, etc.
5/32-in.	For building up wearing surfaces.

General Rules

In closing it will be well to point out a few general rules required to obtain satisfactory welds.

1. The work must be arranged or chipped so that the electrode may be held approximately perpendicular to the plane of welding. When this cannot be accomplished the electrode must be bent so that the arc will be drawn from the point and not the side of the electrode. For cast iron the studding must be properly arranged and proportioned. The surfaces to be welded must be thoroughly clean and free from grease and grit.
2. The proper electrode and current value must be selected for the work to be done.
3. The arc should be maintained as constant as possible.
4. For nearly all work the prepared surface should be evenly welded over and then the new surfaces welded together.
5. Suitable shields or helmets must be used with proper color values for the lenses.

   For locomotive work a good operator will deposit an average of 1 and 1½ lb. of electrode per hour. The limits are from 1 to 2 lb. High current values give more ductile welds in proportion to deposited metal. For locomotive welding the great advantage of the arc over thermit, oil or acetylene welding is that preparation at the weld is all that is necessary. No secondary preparation for expansion of the members is necessary. This is the great advantage in welding side frames.

German Ships

A fine tribute was paid to railroad work when a committee consisting of railroad men was appointed by Capt. E. P. Jessop, U. S. Navy, to report on the feasibility of making repairs by electric welding to the damaged German ships. This committee, headed by D. H. Wilson, after careful examination reported that it was practicable to weld the damaged parts, as similar cast iron welding work was daily done in railroad shops. Machines and operators borrowed from the railroads were responsible for the speedy and thorough repairs to these ships.

By being able to weld the damaged parts without removing them, the ships were released for transport service in three or four months instead of a year or more, as the Germans anticipated.

The Secretary of the Navy, in his report on the repairs to the German ships, has stated "that the repairs to these ships resulted in a saving of 12 months in time, enabling us to transport at least 500,000 troops to France and effected an economy which is conservatively estimated at upwards of $20,000,000. He further states that there was not a single instance of a defective weld, nor has one developed during the months of arduous service in which these ships have been engaged."

When it is considered that these repairs released a tonnage of nearly 290,000 tons, it will be realized what an important part electric welding played during the war.

Electric Car Lighting

By A. G. Oehler

Associate Editor, Railway Age

It is generally conceded that the railroads are in need of much new passenger car equipment. This, of course, includes car lighting equipment, and those interested in car lighting are asking what the equipment will consist of and how much is needed.

At one time cars were lighted with candles. Candles were superseded by oil lamps, and oil lamps in turn were largely displaced by gas light. Now, if present day practice is continued, gas will in time become little more than a memory.

Types of Equipment in Use

Electric train lighting can be divided into three general classes, *i. e.*, head end, straight storage and axle systems. Head end systems usually consist of a steam turbo-generator set located in the baggage car, supplied with steam from the locomotive, working in conjunction with two or more storage batteries placed on the coaches. Where head end systems are used in conjunction with electric locomotives, a motor-generator set on the locomotive supplies the power for train lighting. For short suburban trains, some consideration is being shown to the use of a turbo-generator set located on the locomotive. The cars for this service are equipped with train lines, but without batteries. There is also a head-end axle system in which a large axle generator in the baggage car supplies power for lighting all the cars in the train. Straight storage lighting is still in use to a considerable extent, but is rapidly displaced by axle lighting systems.

There is still a large percentage of gas lighted cars in use in the United States, but the general tendency is to adopt the 32-volt axle generator systems.

There are six different types of axle lighting systems manufactured in the United States, each of which has its merits. Practically all of this equipment which is in service, is belt driven and generators are either truck-mounted or body-hung. There are two general types of batteries, namely, the lead-acid and the nickel-

iron. There is but one make of nickel-iron battery, but several of the lead-acid type.

Maintenance

The two biggest maintenance costs are, first, batteries and second, belts. Battery maintenance is kept at a minimum by keeping battery compartments and containers clean and painted, by proper flushing and particularly in the case of the lead cells, by avoiding excessive overcharge and complete or nearly complete discharge. It is also essential that the battery box be dust tight, that vent plugs be kept in place, connectors carefully maintained and regular inspection made for leaky tanks and general repairs.

There are different kinds of current control for maintaining proper charge in the batteries. In this connection it is of interest to mention the fact that modern practice indicates that the cutting in speed of the automatic switch is of much less importance than the minimum full load speed of the generator. The size of the generator and of the battery is governed by the kind of car and the class of service in which the car is to be used. Recommendations have been made by the Association of Railway Electrical Engineers regarding a standard method for rating generators, material for armature shafts, bearings, grease retainers, etc., which will be of considerable interest to the prospective purchaser. These recommendations will appear in its 1919 proceedings.

The factors of first importance in applying belts, whether for truck-mounted or body-hung generators, are that the pulleys must be in line, that the belt will clear the end sill and brake rigging by at least three inches and that the pulleys run true. This last consideration has been deemed of sufficient importance by the Master Car Builders' Association to warrant the adoption, as recommended practice, of the use of rough turned axles for mounting axle pulleys. Careless switching in the yards is a common cause of belt trouble. Belts may be snapped off in the yards in this way, or so strained that they are lost when the generator load is applied.

Two gear-driven machines have recently appeared in the field which may prove to have considerable merit. Other types of gear and direct drive have been tried out in the past and discarded because of inherent faults such as difficulty of applying and removing the equipment and the high first cost. Much progress has been made, however, in the last few years in the use of gears in general and should a special axle be considered essential for belt operation, there would be several added arguments in favor of a gear drive.

Lighting Fixtures

The selection and placing of lighting fixtures in the cars has become a problem in illuminating engineering, and, following modern lighting practice, the tendency has been to provide general illumination with a few large units, placed along the center line of the car. Fixtures are designed and placed so as to give a certain number of foot candles illumination on the reading plane. Aside from light intensity are considered efficiency, uniformity, distribution, quality of illumination produced and artistic merit. For coach lighting and other classes of cars where efficiency is the primary object, the open-mounted reflector is the one most universally used, and where appearance is the primary consideration, enclosing units are usually applied and efficiency somewhat sacrificed.

Special lighting is required for certain cars and consists of berth lamps, reading lamps for parlor cars and composite or club cars, and special novelties for table lighting in diners. Aisle night lights for sleepers are probably the most recent development in car lighting. They are placed under alternate seat ends and consist of a fixture fitted with a ten-watt straight side bulb which throws light onto the aisle carpet through a green glass. They tend considerably to enhance the value of the upper berths. For postal cars, the specifications of the Standard Car Committee of the Post Office Department must be met. Aluminum or aluminized metal reflectors are in very general use in postal and baggage cars, due to their high efficiency and durability.

Lamps

Both the type B and type C tungsten lamps are used, the type B supplying the need for units of 50 watts and less, and it appears that the type C lamps will be used to fill the requirements for 75 and 100 watt units. The type B lamps are made both as round and straight sided lamps. Based on 1918 records, the sales of straight sided lamps exceeded those for round bulb lamps. This is probably due to the lower cost of the straight sided lamp, particularly in the larger sizes.

Train Lines

The time is too short to say more about car wiring than to mention the fact that the practice of equipping cars with train lines is generally recommended. It has been practically demonstrated that good train lighting service may be had without them, but it is apparent that facilities for train line connections will greatly reduce the possibility of light failures. They are particularly desirable for the protection of mail cars.

Amount of Equipment Needed

I have stated that the railroads were in need of passenger cars and have endeavored to outline the fundamental considerations which enter into the purchase of car lighting equipment. Perhaps you would be interested in an estimate of how much the railroads are short.

Between the years 1910 and 1916, the number of passenger cars in service increased from 47,095 to 54,774 or 16 per cent. Meantime, the increase in amount of travel was 36 per cent. In 1917 the increase in the number of passenger cars in service was 1,167.

Government control was established at the beginning of 1918 and during that year only 131 cars were ordered for all the railroads. This year no substantial orders for passenger cars have been placed and owing to retirement of cars, there may have been some decrease.

Passenger traffic in the meantime has increased. As already stated, the increase in travel from 1910 to 1916 was 36 per cent. In 1917 alone, it was 14½ per cent. In 1918 the increase over 1917 was 8 per cent. In the first eight months of 1919, the passenger business handled was 6.3 per cent greater than that handled in the same months of 1918. These cumulative increases since 1916 aggregate 32 per cent.

The large increase in passenger traffic in 1917 and 1918 has been attributed chiefly to the movement of troops and to the traveling of their relatives and friends to and from the cantonments where they were located. Since 1918, however, there has been a very large reduction in the movement of troops, and yet the statistics of the Railroad Administration show that the amount of travel in July, 1919, was 12½ per cent greater than in July, 1918.

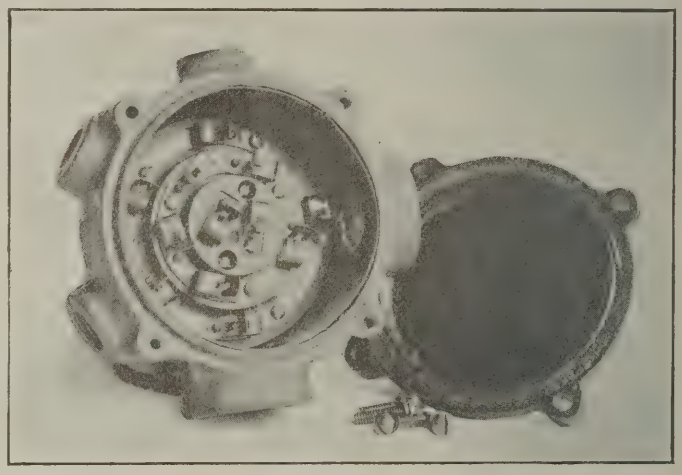
There is no apparent reason for doubting that the present large amount of travel will continue, and even increase. In addition to this, the railroads have had to postpone their steel car program and, of course, in the past the replacement of wooden by steel passenger equipment has been a very important factor. If the railroads during the last three years had bought only as many passenger cars per year as they did in the preceding six years, they would have bought in this three years at least 7,000 more cars than they actually did. But the increase in passenger business in the last three years has been almost as great as in all of the preceding six years together. Taking into consideration both the very small number of passenger cars that has been bought during the last three years and the enormous increase in passenger business which has occurred, it is safe to say that the railways after they are returned to private operation would have to have at least 8,000 and probably 10,000 more passenger cars than they actually will have in order to handle their passenger business in the same way that they handled it in 1916.

The largest number of cars ever built in one year in the United States and Canada was only 4,412, so the conditions can not be entirely corrected at once, but I hope that consideration of these figures may aid the car lighting men in anticipating the size of the job they have ahead of them.

ELECTRIC WIRING FOR STEAM LOCOMOTIVES

The outlet box shown in the illustration was designed by the New York Central electrical department for headlight wiring in connection with high power electric headlight equipment for steam locomotives and is a development worthy of consideration. Mechanically, the box is a joint or elbow which connects the vertical and horizontal handrails on the smoke box. Electrically it is an outlet or junction box which connects the three main wires from the turbo-generator to the individual circuits for the headlight, classification lamps and marker lamps. Any wire entering the box can be readily connected or disconnected with no tools except a screw-driver for taking off the cover.

Inside of the box there is a terminal block made of a single piece of moulded insulation on which there are three brass connecting strips or busses to which are attached the wire connectors arranged on three levels. There are five Fahnestock clip connectors on each, the lower and middle levels, attached directly to the circular busses on these levels, and two of these connectors on the top level attached to the third bus which is rectangular in form and recessed in the bottom of the block. Three wires enter the right hand side of the box. These are the number, marker and classification lamp positive, the number, headlight, marker and classification lamp negative and the headlight positive wires and they are connected to the busses for the lower, middle and upper levels respectively. Wires leading out of the bottom outlet of the box are carried through the vertical handrail and conduit to the marker lamps on the pilot beam. Out of the other three outlets, from lower left to top, are taken wires to the left hand classification lamp, to the headlight and number lamp and to the right hand classification lamp.



Outlet Box with Terminal Block in Place

The lower and right hand outlets are tapped for 1¼ in. pipe and the other three for ½ in. pipe. The busses on the two lower levels are secured to the block of moulded insulation by brass bolts with heads countersunk in the insulation. The clip connectors are riveted to these busses. The clip connectors on the top level are slightly recessed in the block to prevent turning and are secured with the bus to the moulded insulation by brass bolts. The block is secured in the box and the cover held in place by brass machine screws fitted with lock washers. The side and bottom of the box are insulated with compressed asbestos fibre sheet packing and the groove in the cover is provided with an asbestos gasket.

Practically all of the New York Central locomotives which are wired for headlights are now equipped with these junction boxes, and they have been found to fulfill all requirements. Vibration will not loosen the wires in the connectors and the box is a great convenience when it is necessary to test out a circuit or renew a run of wires, as no taped connections are used.

Locomotive Boiler and Fire Box Arc Welding*

The Use of the Electric Arc in the Construction and Repair of Such Apparatus Requires Skilled Operators

By E. Wanamaker and H. R. Pennington

AMONG the first commercial applications of the arc welding process on the railroads was that of repair work and flue welding; i. e., the welding of the boiler tubes to the tube sheet in locomotive boilers. In this field the process has been constantly expanded and at the present time it is used extensively by many of the large railroads.

In a number of cases the success of the process for joining steel plate has been so thoroughly demonstrated that riveted seams in locomotive fire boxes have been entirely eliminated, and many such fire boxes are in successful operation. That these results have been obtained is due to the development of the art and its application and not to any new fundamental discoveries.

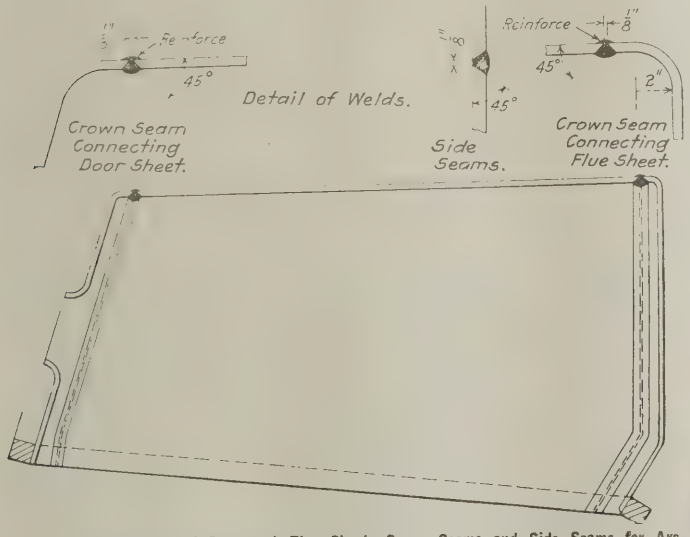


Fig. 1. Preparation of Door and Flue Sheet, Crown Seams and Side Seams for Arc Welding New Fire Box

There have been, however, great strides in the refinement of the equipment, electrode material, methods of application and last but not least skilled operators have been produced, which is especially vital in boiler welding.

Completely Welded Fire Boxes

In the application of new fire boxes, the seams of which are to be arc welded, the door sheet and the flue sheet are prepared with flanges of not less than 2½ in. as shown in Fig. 1. The one piece sides and crown sheet are set and securely bolted to the mud ring. The door sheet and flue sheet are then likewise set in place. The edges of all sheets should be beveled to a 45 deg. angle from the fire side, leaving an opening between all edges to be joined of approximately ⅛ in.

*This is the ninth article on Electric Welding, by E. Wanamaker, electrical engineer of the Rock Island Lines, and H. R. Pennington, supervisor of welding and electrical equipment, Rock Island Lines. Copyrighted 1919 by the RAILWAY ELECTRICAL ENGINEER.

The four vertical seams are welded with the fire box in the normal position. In order to avoid unnecessary distortion of the sheets each seam is welded in sections in the order shown in Fig. 2. The first section welded should be approximately 3 in. long and should be finished flush before starting the second section. The second and remaining sections may be as long as 10 in. In all cases each section should be finished at least flush

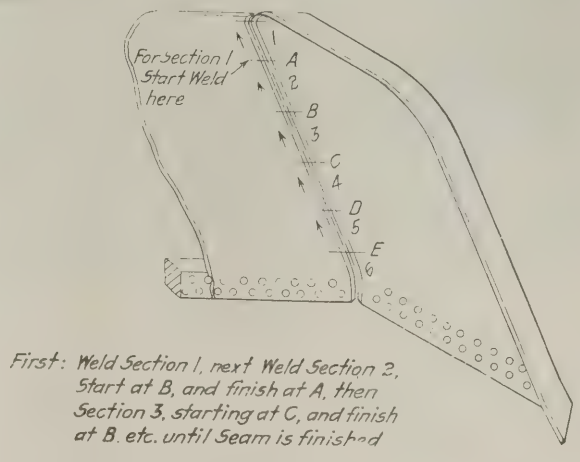


Fig. 2. Method of Procedure in Welding the Four Vertical Seams on a Fire Box

before starting another. The finished weld should be reinforced approximately ⅛ in. Views of side and crown sheet arc welding are shown in Figs. 3 and 4.

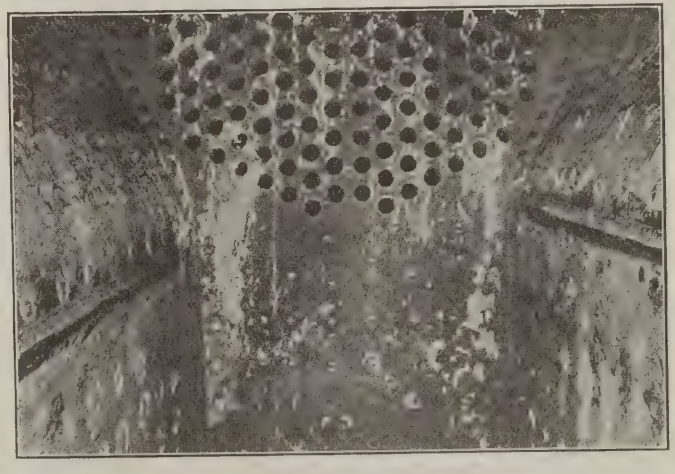


Fig. 3. Side Sheet Joints Welded with Electric Arc

The size of the electrode to be used for fire box plate thickness is 5/32 in. A 3/16 in. electrode may be used especially between flue sheet and middle sheet, owing to the greater thickness of the flue sheet. The heat value should always be as great as is consistent with good welding.

When starting welds on cold massive parts a greater current density or heat is required for proper fusion than will be the case after the work has warmed up.

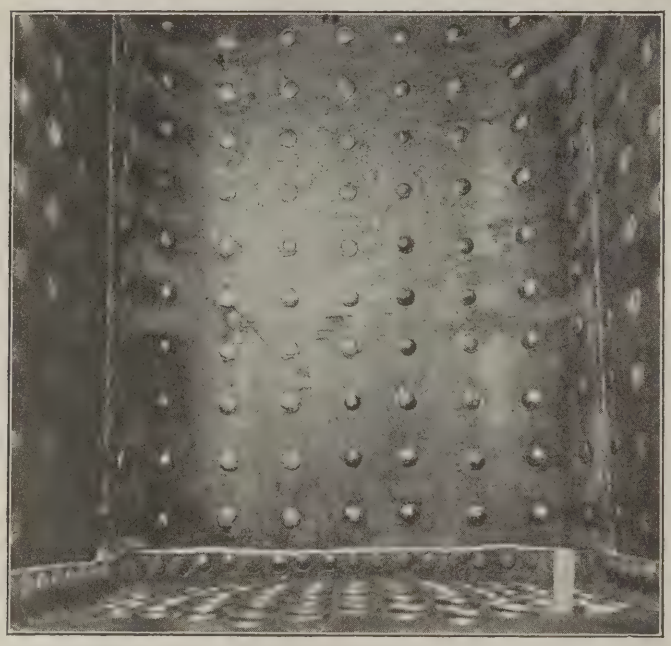


Fig. 4. Joint of Crown Sheet Welded with Electric Arc. Photograph taken looking up From Drop Pit

To avoid readjustment of heat it is good practice to start the weld with a smaller size electrode than that for which the heat is adjusted and when the part warms up change from the smaller electrode to the next larger size.

When it is possible, the top seams of a new fire box should be welded with the box laying on its side. This will avoid overhead welding and will place the crown seams in a vertical position; thus permitting the welding to be done in the same manner as that just described for the side seams; i. e., weld in sections, using the back step method, welding in an upward direction. The top seams should be slightly reinforced on the water side, as well as on the fire side.

If "Thermic Syphons," shown by Fig. 5, are to be applied together with a new fire box, the seams connecting the syphon to the crown sheet should be welded with the box on its side, which will place the long seams of the syphon in a horizontal position. These seams should be reinforced on both the water and fire sides. The diaphragm plates, shown in Fig. 6, may be welded to the flue sheet with the fire box in either position, since the location of the joints to be welded eliminates overhead welding in either case. These seams should also be welded in sections, as previously described.

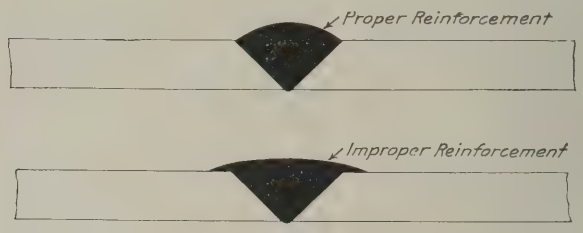


Fig. 7. Proper and Improper Reinforcement

The object of beveling the edges of all seams from the fire side is that in the event of making any repairs along the line of weld, which of necessity must be done from the fire side in most cases, it would not be necessary to make such large openings to remove the old welded in metal. Extreme openings must be avoided, as it has been demonstrated in service that such welds cannot be depended upon. This is due no doubt to the fact that if the weld is not reinforced the cast metal applied in the large opening possesses less strength than the original plate and will break when slightly distorted. If on the other hand a wide section of this kind is built up in an effort to stiffen the line of weld, the greater thickness will result in a greater temperature at that point, which may result in local strains that cause rupture. No more of the original metal should ever be removed than is necessary to provide access to insure fusion all along the entire edges to be joined and the width of the reinforcement should not be more than the opening between the beveled edges at the widest point. Proper and improper reinforcement is shown in Fig. 7. Arc welds do not tend to break along the line of union when properly made; the weakest point

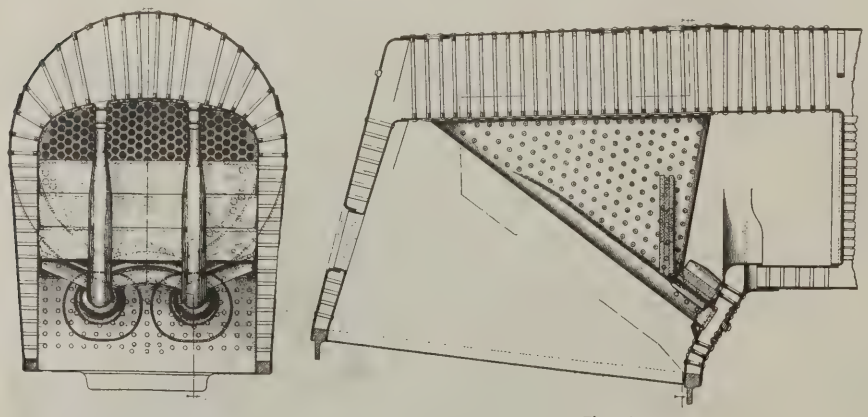


Fig. 5

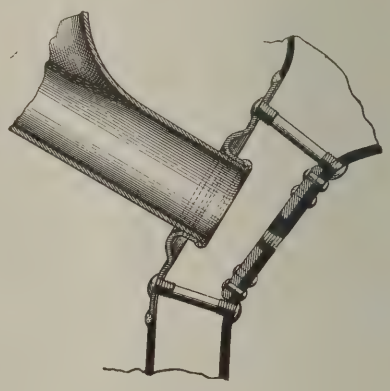


Fig. 6

Fig. 5. Two-Syphon Application to a Medium Width Fire Box with a Combustion Chamber. Fig. 6. The Diaphram Plate Welded In By Means of Electric Arc

is through the cast metal, for this reason the center of the weld should have the greatest thickness.

The door hole flange seam may be butt welded, using the back step method or it may be lap welded, as shown by Fig. 8. Both methods are used and both are in successful operation.

The objections raised by some to the lap weld is that scale will form between the unwelded edges on the water side and produce a prying effect. However, no such trouble has developed so far as can be learned from those using the lap type joint at the door hole flange seam. A lap welded joint for the door hole flange seam is less difficult to perform than is the butt weld joint and if it is as good, it is preferable. A view

Fig. 8. Two Types of Door Hole Flange Welds

showing an arc welded seam across the outside door sheet is illustrated in Fig. 9.

Mud Ring

It is the practice to weld the edges of the sheet to the mud ring to prevent leaks from developing, as shown by Fig. 10. The edges of the sheet should first be beveled and in order to securely join the sheet to the

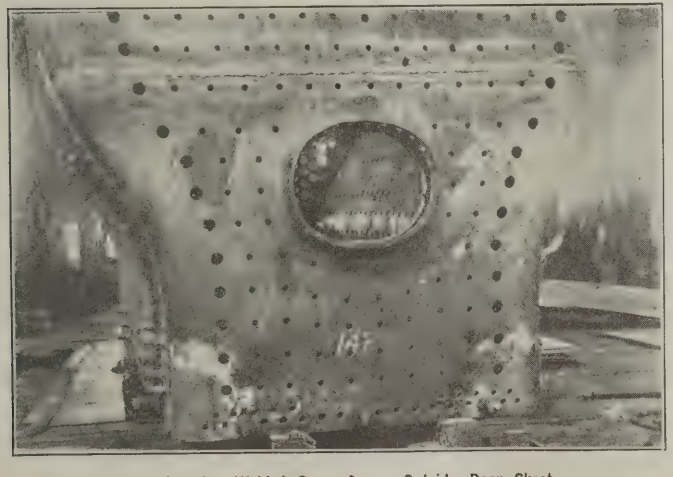


Fig. 9. Arc Welded Seam Across Outside Door Sheet

ring a space on the ring, at least equal to the thickness of the sheet should be provided and cleaned with a roughing tool. The usual practice is to extend the weld approximately 12 in. from the corner each way. In the case of riveted lap seams in the fire box the weld is also extended along the edges of the flange seams above the grate frame. A 5/32 in. electrode is appropriate for this work.

Many mud ring corner welds have failed, due to the fact that the sheet extended down so near the bottom edge of the mud ring that only a very light weld could be made, and as the mud rings are usually hammered iron, having laminated characteristics the corners would tear out. This feature must be given additional consideration in boiler construction if the best results are to be obtained from welding the edges of the sheets to the mud ring. The edge of the sheet should not extend

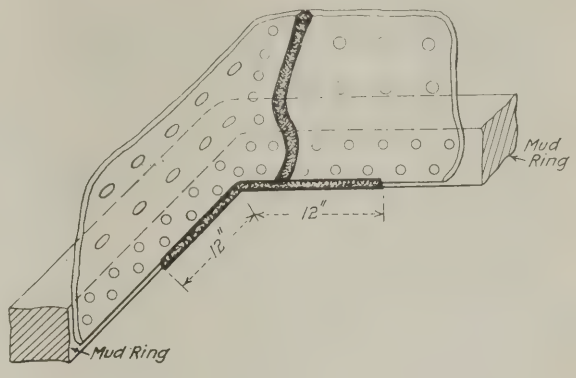
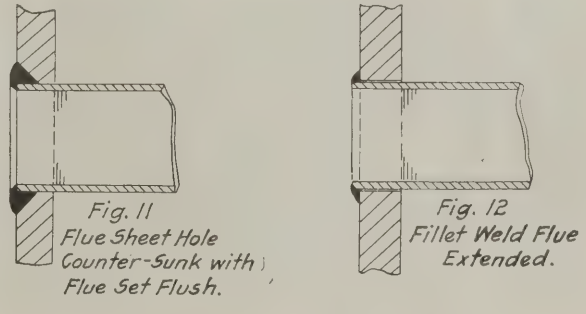


Fig. 10. Welding the Edges of the Sheet to the Mud Ring

nearer than ½ in. to the bottom edge of the mud ring At present it is difficult to obtain ¼ in.

Welding Tubes to the Tube Sheet

The welding of tubes to the flue sheet is not as simple an operation as it may at first seem. Every conceivable method of flue setting has been tried; many methods had little or no commercial value. For example, flue sheet holes have been counter sunk to provide an opening for the added metal, and the flues set flush with the fire side of flue sheet, as shown in Fig. 11. In other cases the flues were simply set and rolled, allowing flue to extend beyond flue sheet a slight distance to permit a fillet weld, as shown by Fig. 12. This practice is still in effect to some extent in some parts of the country, especially with the large flues. Among the most important factors that determine the performance of flues is, of course, the water conditions and with welded flues,



Figs. 11 and 12. Two Types of Flue Welding

as with unwelded flues, the water conditions will determine to some extent the method of application.

In general the best and safest practice is to use the welding process to seal the joint between the flue and the flue sheet and not depend entirely upon the weld to anchor the flue to the sheet, as the relatively small amount of cast metal will not alone withstand the severe strains imposed upon the flue joint, especially when water conditions are bad. The surface of the flue sheet should be as smooth as possible in order to reduce the

tendency of honey-combing. This is especially necessary with fire boxes not equipped with brick arches.

The practice that is considered to be the best for

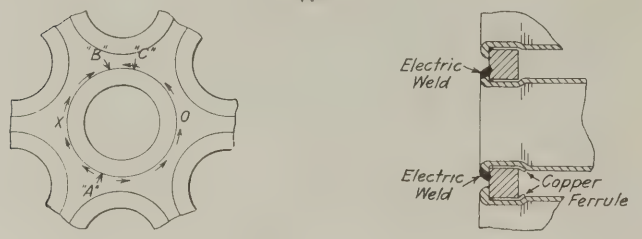


Fig. 13. Showing Method of Procedure in Welding Beaded and Expanded Flues

preparing and welding locomotive boiler tubes at the present time is as follows:

(*1*) The flue sheet around the edges of the flue hole should be perfectly clean. This may be accomplished with sandblast, roughing tool, or with a wire brush if the scale is not too bad.

(*2*) Copper ferrules placed in the flue sheet holes should be set 1/16 in. back from the edge of the water side of the flue sheet.

(*3*) Soap water should be used as a substitute for oil as a lubricant for the expander. Oil must not be present from any cause.

(*4*) When the flues are applied they should extend through the sheet approximately ¼ in., then rolled and flared, after which they should be expanded with a Prosser expander and finished as though they were not to be welded, after which the sheet around the flue heads should be cleaned by sandblasting—or if not too dirty it may be cleaned with a wire brush and then welded in the following manner:

Start the welding at the bottom of the flue at point *A* as shown in Fig. 13 and weld in an upward direction,

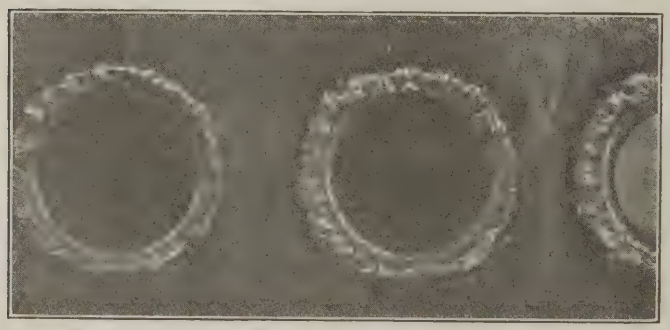


Fig. 14. Showing Beaded and Expanded Flues By Means Electric Arc

A-O-B, then return to point *A* and weld in an upward direction, *A-X-C,* lapping over the end of the first bead approximately ½ in. This will avoid the possibility of pin holes where the arc was broken at the finishing point of first head. The deposited metal should not project farther than flush with the flue head.

For 2 in. flues a ⅛ in. electrode is generally used, with a heat value slightly above the normal value used for this size electrode. For 5 in. flues a 5/32 in. electrode should be used, with as much heat as is consistent with good welding. In both cases the heat value must be sufficient to properly fuse or penetrate the heavy flue sheet, which will, of course, tend to fuse away the comparatively thin tube bead unless proper care is exercised. To avoid the burning of the bead the major portion of the arc flame should be directed against the flue sheet, or the arc flame should be played upon the flue sheet more than upon the flue bead.

As the thin edge of the flue bead is fused through by the arc, if the surface around the edges of the flue hole is scaly, or otherwise dirty, an excessive heat or undue manipulation of the arc would be required in order to slag off scale or dirt and secure fusion between the flue bead and the sheet. This would make a smooth weld difficult and would tend to cause burned metal in the weld.

If the copper ferrule extends out under the flue bead when the welding begins to arc will be erratic, owing to the difference in the conductivity of the two metals from which the arc is established. This will also make

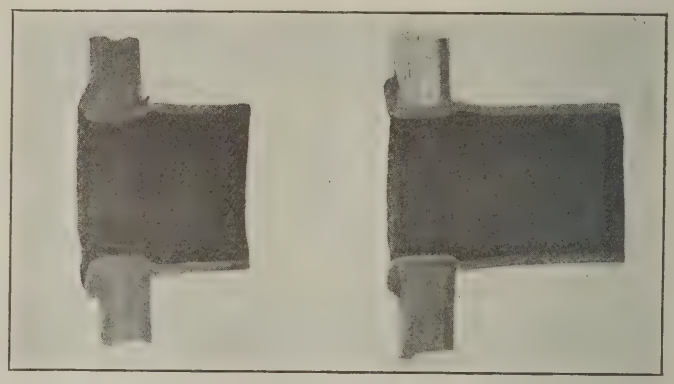


Fig. 15. Sections of Beaded and Expanded Flues Welded by Means of Electric Arc One With and One Without Copper Ferrule

a smooth, sound weld practically impossible. If oil is present the oil and the soot formed by the burnt oil interrupts the arc and the flow of the metal. It has been found that hardness is increased with the presence of oil, which is doubtless due to the excessive oxidation incidental with a weld arc.

The flues should be applied the same as though they were not to be welded for the reason previously explained; i. e., to assist the weld in anchoring the flue and to make a smoother finished job. The copper ferrule may be ommitted if the water conditions are exceptionally good. If the water condition does not permit the boiler to be kept clean and free from scale the temperature of the surfaces exposed to the fire will, of course, be increased. For this reason it is evident that the copper gasket or ferrule setting will withstand the excessive distortion due to the increased temperature.

If a welded flue should develop a leak the old weld of the leaky flue should be entirely removed and the flue thoroughly worked with expander and beading tool and then welded. This can be done best if the original flue setting was made with the copper ferrule.

It is the practice of some roads to have the locomotive fired up or to make a trial trip before welding the flues; this is beneficial if oil is used in applying the flues.

If such has been the case the oil would be burned off, this permitting a better weld to be made. The theory has been advanced that the boiler should be allowed to make a trip or to be fired up in order to permit the

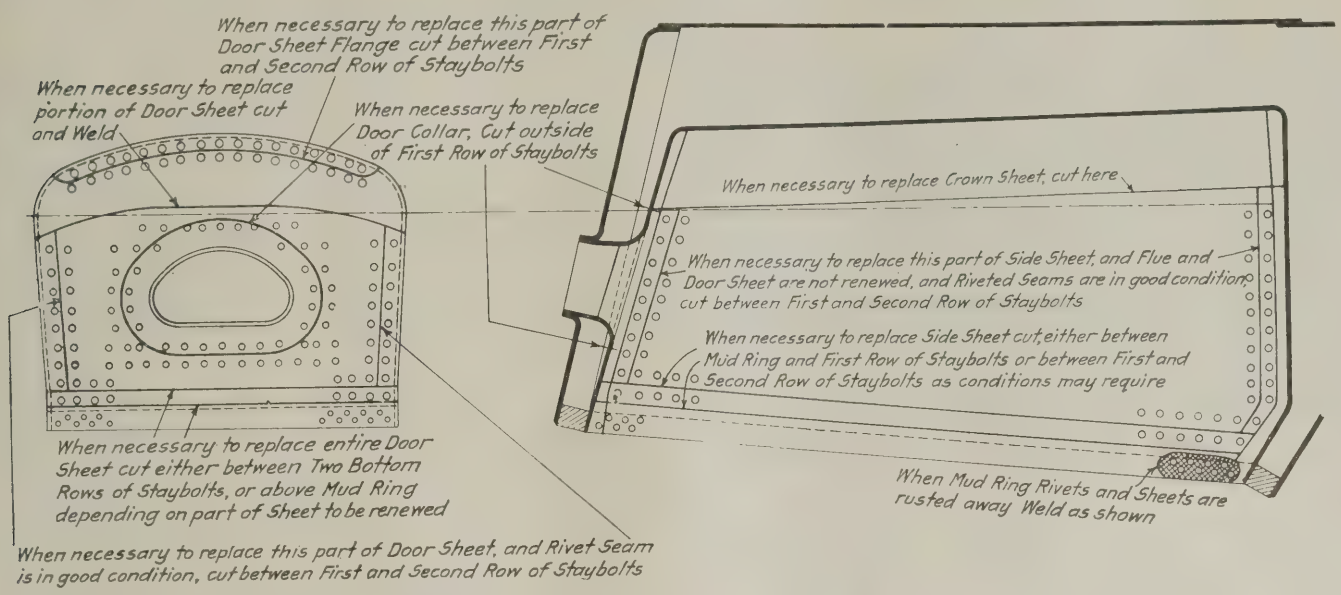

When necessary to replace this part of Door Sheet Flange cut between First and Second Row of Staybolts
When necessary to replace portion of Door Sheet cut and Weld
When necessary to replace Door Collar, Cut outside of First Row of Staybolts
When necessary to replace Crown Sheet, cut here
When necessary to replace this part of Side Sheet, and Flue and Door Sheet are not renewed, and Riveted Seams are in good condition, cut between First and Second Row of Staybolts
When necessary to replace Side Sheet cut, either between Mud Ring and First Row of Staybolts or between First and Second Row of Staybolts as conditions may require
When necessary to replace entire Door Sheet cut either between Two Bottom Rows of Staybolts, or above Mud Ring depending on part of Sheet to be renewed
When Mud Ring Rivets and Sheets are rusted away Weld as shown
When necessary to replace this part of Door Sheet, and Rivet Seam is in good condition, cut between First and Second Row of Staybolts

Fig. 16. Showing Where Cuts Are to be Made When Repairing Various Parts of Fire Box

flues to take a setting under heat conditions, but this is not considered necessary when the flues are applied and welded as has been outlined. From the foregoing

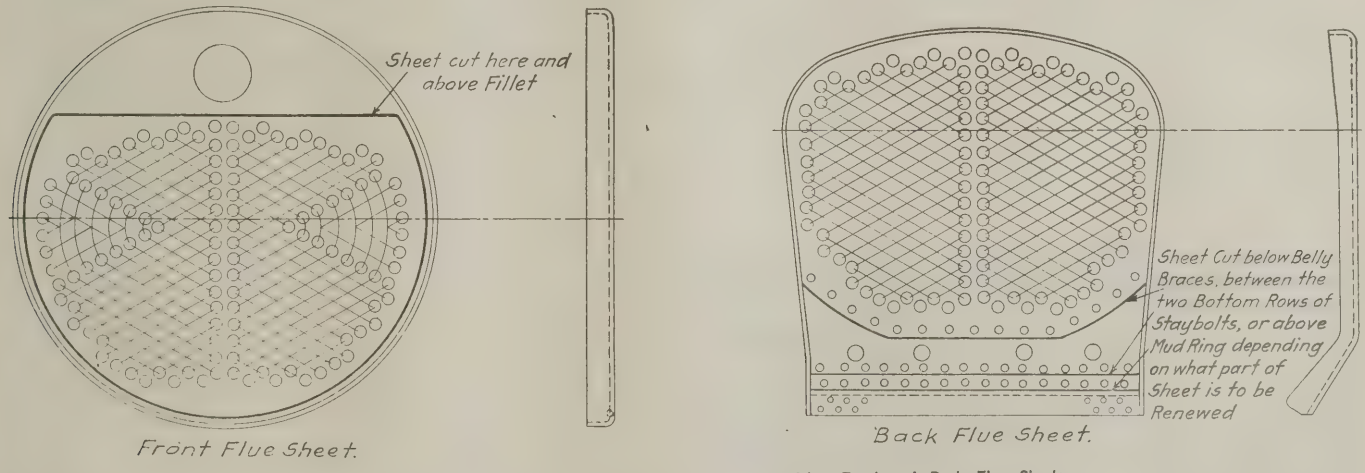

Sheet cut here and above Fillet
Front Flue Sheet.
Sheet Cut below Belly Braces, between the two Bottom Rows of Staybolts, or above Mud Ring depending on what part of Sheet is to be Renewed
Back Flue Sheet.

Fig. 17. Showing Where Cuts Are to be Made When Repairing Front and Back Flue Sheets

it is apparent that the welding of flues is an additional expense to be added to the cost of installing flues; however, this added first cost is many times offset by the decreased operating expense.

The following table serves to indicate the present speed and cost of welding tubes and flues; although it has been demonstrated that it is possible to weld double the number of flues per hour than is given.

Cost of Welding Small Tubes

	Per Tube
Average cost per tube at the rate of 15 per hour, figuring labor at 77 cents per hour, and welding iron and power at 25 cents per hour	$ .068

Cost of Welding Large Flues

	Per Flue
Average cost per tube, at the rate of 3 per hour, figuring labor at 77 cents per hour, and welding iron and power at 25 cents per hour	0.34
Cost of welding tubes in one engine of 229 tubes at 6.8 cents per flue	25.57
Cost of welding tubes and flues in one engine of 190 small tubes at 6.8 cents per tube, and 30 large flues at 34 cents per flue	23.12

The cost of the welding iron and power is based on the average price of iron and upon the power consumption of a modern welding equipment and the average cost per kilowatt-hour for power.

On a central western road, where welding of tubes and flues to the tube sheet is standard practice, according to the general boiler inspector the performance is as follows:

The running repairs on flues and tubes on engines with welded flues has been reduced to almost nothing.

More than 50 per cent of the engines that have had flues welded a year or more ago are returning to the shops after running 50,000 to 90,000 miles without ever having any work done on the flues. The condition of the flues on their arrival at the shops was such that only the lower part of the flues, where the scale is

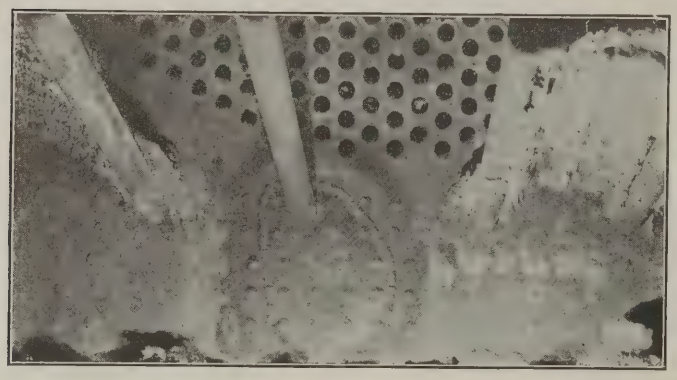


Fig. 18. Patch on Flue Sheet and Around Arch Bar Welded with Electric Arc

heavy, was renewed. The upper half of the small flues and usually all of the superheated flues on practically all of the superheated engines as well as a large number of the saturated engines ran two shoppings without leaking before they were changed. It is evident, therefore, that the additional expense of welding the flues is many times offset, especially when water conditions are bad.

The tendency to honey-combing is no greater with welded flues than when the flues are not welded. Scale and dirt may be more noticeable with welded flues, but this is usually due to the less frequent working and hammering on the flue sheet. For the same reason slightly more scale may form on the water side of the flue sheet. It is, however, certainly less work and ex-

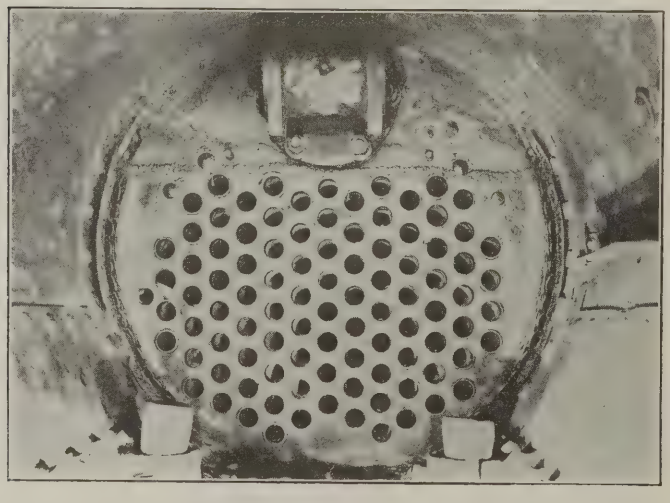


Fig. 19. Front Flue Sheet Joints Welded with Electric Arc

pense to clean off the flue sheet occasionally than to expand the flues every few trips and caulk them possibly every trip.

The life of a flue sheet is greater where the flues are welded and the liability of cracks are less, owing to the destructive effects produced by the frequent rolling and working of the flues being practically eliminated. Views of beaded and expanded arc welded flues are shown in Figs. 14 and 15. In the photographic reproduction, Fig. 15, sections of two welded flues are shown one with and one without copper ferrule.

Boiler Repairs

The manner in which some of the different parts of the fire box are cut out when it becomes necessary for them to be renewed, is shown in Figs. 16 and 17. Views of repaired flue sheets are shown in Figs. 18 and 19. When sheets or patches are cut out, care should be exercised to select a location that will afford a good foundation for the weld. Cutting through stay-bolt holes, arch tube holes and old welds should be avoided.

The surfaces of all beveled edges must be finished by chipping. This is necessary to secure a uniform line and opening between the edges to be welded and to insure clean surfaces on which to weld. All foreign substances must be removed to prevent slag inclusions

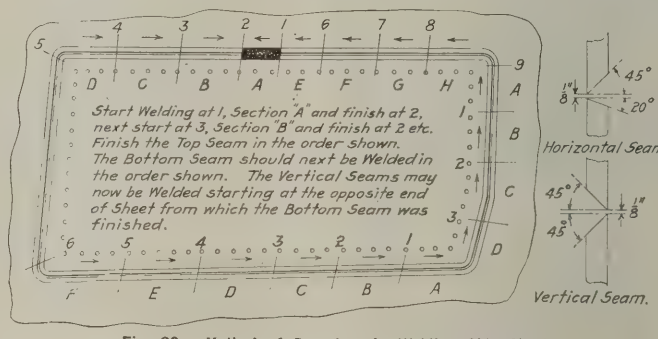

Start Welding at 1, Section "A" and finish at 2, next start at 3, Section "B" and finish at 2 etc. Finish the Top Seam in the order shown. The Bottom Seam should next be Welded in the order shown. The Vertical Seams may now be Welded starting at the opposite end of Sheet from which the Bottom Seam was finished.
Horizontal Seam.
Vertical Seam.
45°
20°

Fig. 20. Method of Procedure in Welding Side Sheets

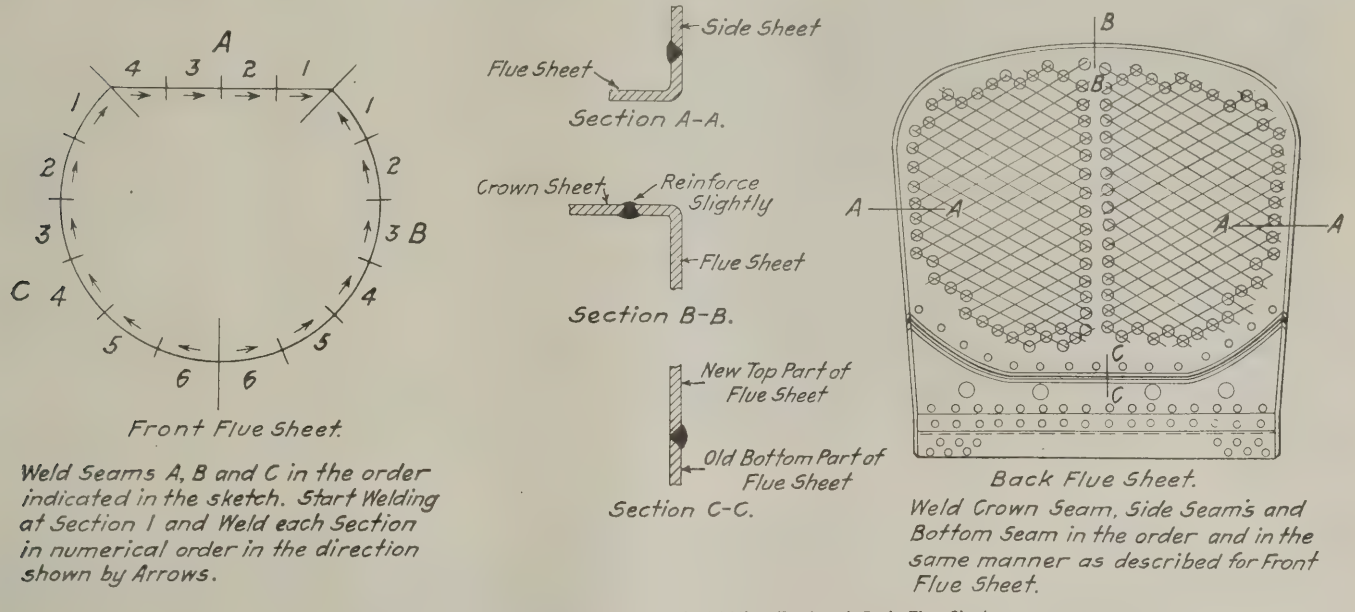
which if present will greatly impair the strength of the joint.

The bottom edges of all horizontal seams will not require as much bevel as other edges, a 20 deg. angle will be sufficient. All other edges, i. e., the top edges of horizontal seams and both edges of vertical or flat seams should be beveled to a 45 deg. angle. An opening of approximately 1/8 in. between beveled edges has become standard for fire box plate.

There are two conditions in boiler work under which welding must be done; one is rigid welding, and as its name indicates, the parts oppose free play. The other condition is the opposite. The former condition, however, predominates in boiler work. Rigid welding is not so difficult if properly done, as explained in the fifth article of this series under the heading "Method Used to Resist Contraction Strains", a part of which reads as follows:

"If two pieces of metal are allowed to lie loosely, free to move, they will warp and distort in their relative positions during the process of welding. * * * Yet, if they are clamped rigidly, the stresses which are set up are taken up almost entirely by a slight giving-in of the weld on cooling, so that when the parts are

released there is no tendency for them to spring out of shape, nor is there any apparent lack of strength which may be regained by supposedly releasing the strain by annealing." It was for this reason that the back step method of welding has been adopted for all seams. The method itself establishes practically rigid welding where the metallic arc process is used, thus



Figs. 21 and 22. Method of Procedure in Welding Front and Back Flue Sheets

avoiding considerable distortion of the sheets and possible concentration of contraction strains at one point which so often causes rupture. This method eliminates much of the expensive corrugating of sheets, etc., which is practiced by a number of roads. The only provisions for expansion and contraction considered necessary with the "back step" method is to give a slight roll to sheets and to slightly dish patches.

Side sheets should be set and bolted in place—staybolts screwed in from the wrapper sheet may be used

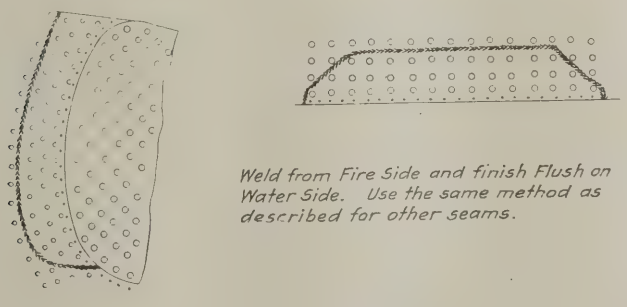


Fig. 23. A Crown Patch Weld

to push the sheet in one direction and bolts to draw in, in the opposite direction, thus aligning the edges. Staybolts may then be applied every fourth or fifth hole in the row adjacent to the line of weld.

The electric material most commonly used in fire box welding is mild steel in the ⅛ in., 5/32 in. and 3/16 in. sizes—of these sizes the 5/32 in. is the most extensively used. The ⅛ in. is often used when the edges are very thin or when the opening between edges is small. The 3/16 in. is sometimes used for the first layer in order to fill the opening approximately flush with one run, afterwards applying the finishing layer with a 5/32 in. or ⅛ in. electrode.

The heat value should always be as great as can be used without burning the added metal or overheating the sheet adjacent to the weld. With the proper heat the sheet will develop a dark red heat a distance of ¼ in. around the point where the arc is drawn, shortly after the welding is started.

It is the usual practice to allow slightly more opening at the top seam which is welded first, than the bottom

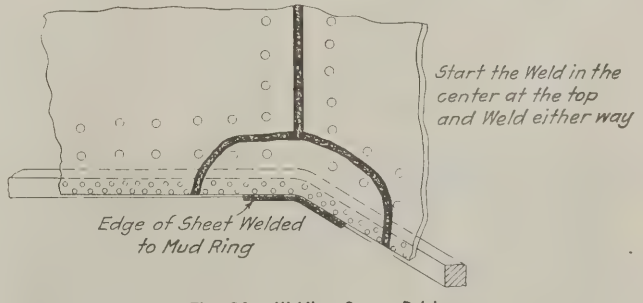


Fig. 24. Welding Corner Patches

seam, to allow for the slight drawing. If the opening is greater at one end than at the other, the welding should progress toward the end having the greatest opening.

The seams of side sheets should be welded in the order shown in sketch, Fig. 20. Front or back flue sheet cut out as shown in Fig. 17, should be welded by laying the seams off in three or four sections and welding in the order shown in Fig. 21 for the front flue sheet and Fig. 22 for the back flue sheet.

If seams are welded from an overhead position the metal deposited between the beveled edges will sag slightly, leaving a concave type of weld on the side opposite that from which the welding is done. It is

for this reason that crown seams should be gone over on the water side to secure a flush joint and not necessarily to reinforce the joint.

Side sheet patches should have a slight dish. The arc depth of the dish to be approximately ¾ in. The weld should be executed in the same general way as that for side sheets or flue sheets. The method used for welding crown patches is as shown by Fig. 23. The method used for welding corner patches is as shown in Fig. 24.

When cracks develop in the knuckle of the back flue sheet they are welded from the water side if possible

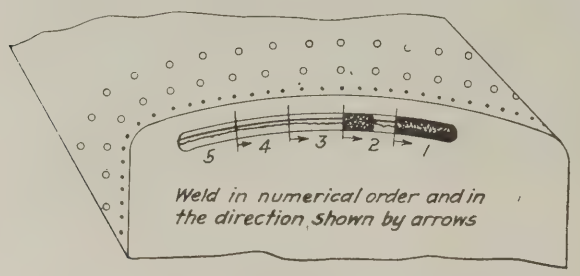


Fig. 25. Method of Procedure in Welding a Crack which Developed in Knuckle of Back Flue Sheet

and slightly reinforced on the fire side. The weld should be made in comparatively short sections as shown in Fig. 25, finishing each section before starting another. This holds true for practically all fracture welding in fire boxes or elsewhere if the parts are rigid.

Fractures extending from one rivet hole to another between the mud ring rivets are welded in the manner as shown by Fig. 26. Fractures above the mud ring that extend from one rivet hole to another should be

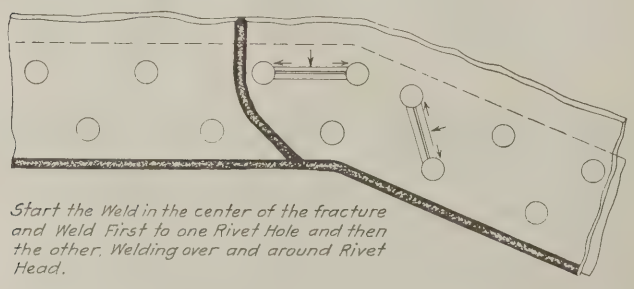

Start the Weld in the center of the fracture and Weld First to one Rivet Hole and then the other, Welding over and around Rivet Head.

Fig. 26. Repairing Fractures Between Rivet Holes at Mud Rings

repaired by applying a patch. It is possible to weld such fracture by applying a round disc as shown in Fig. 27. It has been found difficult to make a weld hold in this location when made without the disc. One disc is used for each hole through which the fracture extends.

Vertical flue sheet knuckle cracks are welded from the water side, starting in the center of the crack and finishing first one half and then the other. Fractures in this location should be repaired in this manner only in an emergency. A new top portion or a new sheet should be applied instead when conditions permit. When cracks develop in the door hole radius a new collar should be applied as shown by Fig. 28. In an emergency, cracks are welded by beveling the edges and welding from the center to one end of the fracture, returning to the center and welding toward the opposite end of the fracture. If two or more cracks are present, each crack should be completed before cutting out and welding another.

Corroded or oversize wash-out plug holes are repaired as shown by Figs. 29, 30 or 31. The washer shown in Fig. 29 is cut in half to permit it to go through the hole and be placed on the water side to serve as a backing for

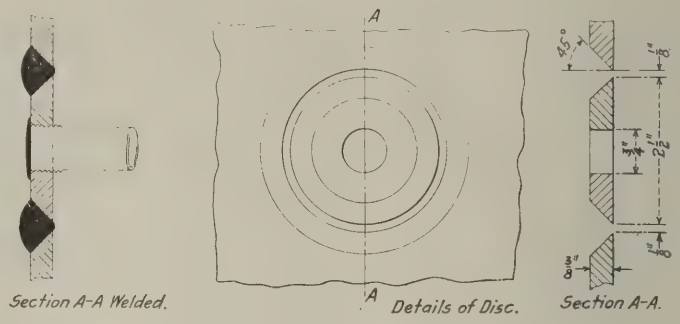


Fig. 27. Repairing Fractures by Means of a Disc

the deposited metal to go against. This same method is often used to fill in stay bolt holes that have become checked around the edges. The sleeve or round disc provides a better metal than the cast filled in metal in which to tap new threads.

Old riveted seams that become defective are repaired by removing the rivets or patch bolts and cutting a bevel on the edges exposed to the fire. The old rivet

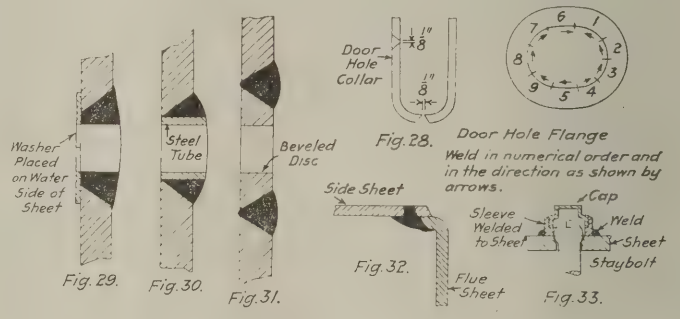


Fig. 28. Method of Procedure in Applying New Door Hole Collar
Figs. 29 to 31. Methods of Repairing Corroded or Over-Size Washout Plugs
Fig. 32. Repairing an Old Riveted Seam
Fig. 33. The Sleeve of a Flexible Staybolt Welded to Sheet

holes are plug webbed after which the beveled edge is lap welded to the adjoining sheet as shown by Fig. 32.

Mud ring corners are best welded by cutting out a portion of the sheet on the fire side to permit access for beveling the fractured edges of the mud ring so that the welding may be done from the top side of the mud ring, afterwards fitting a new patch in place and welding.

A new patented flexible staybolt has been placed on the market, the application of which embodies arc welding. One of the assemblies is shown by Fig. 33.

The arc welding process is used extensively for welding caulking edges on old riveted seams. One example of this is in welding the caulking edge of riveted joints in the smoke box of locomotives when rivets

become loose in order to secure a good vacuum to drafting the boiler. There are many other applications in the construction and repairing of locomotive boilers for the arc welding process of which no mention has been made. The examples cited, however, will serve to indicate the progress that has been made in this field.

PROPER ILLUMINATION IN RAILROAD SHOPS

By R. E. Rice, Electrical Supervisor, New York Central Lines, Bucyrus, Ohio

Although I have read a great deal in technical and electrical journals on proper methods of lighting shops of railway and industrial companies I have noticed very few of the articles gave information on lighting areas that contained obstructions such as posts, pillars, belts, large machine tools, etc.

It is a fact that each individual shop of such nature presents a problem to be solved by the electrical man in charge. Yet it is my opinion, based on recent experience in laying out a system of lighting for a machine shop that had a great many obstructions such as mentioned above, that it is only a question of, first, selecting the proper type of reflectors; and second, proper

Night View of Part of Rod and Link Floor in Toledo & Ohio Central Ry. Shops Bucyrus, O.

spacing of units, both as to distance apart and height from floor, taking care that the shadows cast by obstructions from one unit are corrected by another. This can be done in most cases with the same wattage that would be required to properly light an equal area which contained no obstructions.

A great many railway shops were originally lighted by the enclosed carbon arc lamps. These were replaced by high wattage mazda "B" lamps and upon the advent of the nitrogen lamp, the mazda "B" lamps were replaced by mazda "C"; but the reflectors would remain. This would result in more light for same current consumption yet had the proper reflectors been selected and installed with the "C" lamps, a great deal better distribution would have been obtained. Such installations will be found in great numbers today, especially in small railway shops, most of which are thought hard to light properly on account of the obstructions generally present.

The photographs show a part of the Toledo & Ohio Central Railway company's machine shop at Bucyrus, Ohio, as lighted at present. This shop was poorly lighted, dense shadows were everywhere, yet the current consumption was sufficient to supply adequate light. It was, therefore, decided to rearrange the system and install efficient units.

After the new installation was completed, the photographs were taken, at night, with light from the general lighting units only.

The present units are 300-watt type "C" lamps mounted in Maxalite deep bowl reflectors at a distance of 19 ft. 6 in. from the floor, these lamps re-

Night View of Main Aisle Between Assembling Floor and Machine Floor, T. & O. C. Ry. Shops

placing 500-watt type "B" lamps mounted in shallow bowl reflectors. While it was not possible to reduce the wattage materially, the result obtained is very satisfactory as we eliminated all dense shadows with an increase in foot candles per square foot of floor space.

In making this installation we have used 3/10-watt per sq. ft. floor area, but since no candle power meter was available and we were unable to obtain the exact per cent efficiency of the installation, although we believe we are getting at least 2 ft. candles of intensity.

I believe the gospel of the proper lighting of railway shops, especially small ones, should be spread as it invariably requires as much current to light them with inefficient units or efficient units improperly placed, as it does efficient units properly placed.

A lighting system properly installed, using the modern high efficiency industrial units will be permanent, for the

Night View Showing Part of Rod and Link, and Machine Floors, T. & O. C. Ry. Shops

time is far distant when a more efficient unit will be produced. The modern units will pay a big interest on the investment as they represent a large factor in increasing production, raising the quality of the work and in making the shop safe for the workman.

EIGHTH ANNUAL SAFETY CONGRESS OF NATIONAL SAFETY COUNCIL

The Eighth Annual Safety Congress of the National Safety Council met in Cleveland from October 1 to 4, inclusive. There were in the neighborhood of 4000 plant managers, safety engineers, employment supervisors, executives and others interested in accident prevention and the problems of industrial relations present. Nineteen different sectional meetings were held, these being respectively automotive, cement, chemical, construction, electric railways, health service, local council officers, marine and navigation, metals, mining, packers, paper and pulp, public safety, public utilities, rubber, steam railroad, textile, women in industry and wood-working. In addition there were the general sessions and the round-tables where opinions were voiced and general business transacted.

In the Public Utilities Sessions the following papers were presented: "Preventing Accidents in Gas Plants," by J. F. Conner, "Inspection of Plants of Gas Companies," by Alvin E. Bliss, "Effective Means of Focusing the Responsibility for the Prevention of Accidents upon Foremen," by J. W. Easley, General Discussion, Questions and Answers, "Working Safely on Live High-Tension Lines," by H. J. Burton, "Practice of Operators and Tagging of Switches, Markings and Barriers," by Walter Wagner, Spasmotic Safety Efforts and the Harmful Results," by H. M. Webber.

THROUGH THE COPYING OF THE NOTICE that the Americanization Division could furnish the "Catechism of the Constitution of the United States," published by the National Security League of New York City, into the foreign-language papers, over 130 requests for this pamphlet were received in one week. These requests came from the foreign born themselves.

CLEVELAND AMERICANIZATION COUNCIL has before it the co-ordination and direction of the Americanization work of 50 agencies interested in this work. They believe that by the co-ordination of these activities Cleveland can become one of the most American cities in the United States. The council now has under way a survey of the chief factories. Questionnaires have been sent out asking the number of foreign-born persons employed in each shop.

THE WAY YOU MEET AND GREET A FELLOW worker can make a friend or an enemy of him. You know that. But do you know that if he is a foreigner it can do more, it can make him more friendly to America. Why? Because the foreigner must judge America mainly by the Americans he meets and the way they greet him. Put a smile in your voice; don't make "good morning" sound like "bad morning."

FIFTY YEARS OF PROGRESS WITH THE WESTERN ELECTRIC CO.

Half a century of continuous existence is no new thing in American business but the significance of such a life in the electrical industry is noteworthy because, properly speaking, the electrical industry belongs to the present generation of men. In November of this year the Western Electric Company celebrated the 50th anniversary of its birth. It began in 1869 as a small two man concern, founded by Elisha Gray and Enos K. Barton. The firm was known as Gray & Barton. As the telegraph was practically the only application of electricity which had been brought into any considerable commercial use in 1869, undertaking to manufacture electrical apparatus required not only vision but indomitable faith and energy together with sound business sense. Mr. Barton had those qualities and sensed the opportunity which was offered when he took over the Cleveland shop which the Western Union Company had decided to abandon. Soon after, the new concern moved to Chicago.

Elisha Gray, one of the founders of the company

Before the day of the telephone the little shop manufactured telegraph apparatus, signal boxes, registers, annunciators, call boxes and fire alarm apparatus. After the advent of the telephone in 1875 the company was busy making equipment for the exchanges of the Western Union Telegraph Company. In 1879, the retirement of the Western Union from that field gave the control to the American Bell Telephone Company. This company had hitherto purchased its telephones from competitive manufacturers, but, recognizing the superiority of the equipment made for the Western Union, it entered into a contract with the Western Electric Company which provided that the latter should make all the telephones for the American Bell's use.

E. M. Barton, President Western Electric Co., 1887-1908

The needs of this service quickened the inventive

genius of the company's engineers and brought a corresponding and ever-increasing expansion of its volume of business. The common battery lamp switchboard of today was evolved from the crude switchboard of the early seventies, the attractive desk stand telephone from the cumbersome box type. The paper insulated lead covered cable solved the problem of the necessary increase in the number of open wires as telephone service became popular, and the establishment of trans-continental wire communication and trans-oceanic wireless communication solved the problem of long distance transmission. In the telegraph field the multiplex printer is an achievement of the Western Electric engineers in co-operation with others.

H. B. Thayer, President
Western Electric Co., 1908-1918

To meet an ever-increasing demand for products which it did not make, the company bought such goods of the dealers and resold them to the user. Out of this early relationship of buyer and seller was evolved the great electrical jobbing organization, operating from forty-two distributing houses. These houses perform a two-fold function. By virtue of the supply contracts with the American Telephone & Telegraph Company and associated companies, they supply all the apparatus and supplies needed by these companies, thus effecting tremendous economies as a result of being able to purchase greater quantities than each individual company could.

C. G. DuBois, elected
president of company in 1919

Further than this, each distributing house maintains large stocks of materials and electrical appliances for every possible electrical need. It is prepared to supply materials for building pole lines; for equipping and wiring homes, offices and factories, and for supplying electrical appliances for simplifying housework.

The company also maintains a large manufacturing plant built at Hawthorne, Illinois, in 1903. This plant is constantly being enlarged to meet the fast increasing needs of the telephone manufacturing end of the business. The employes of this plant, together with those from the forty-two houses in the United States and the foreign houses constitute a working force of over 30,000 men and women.

The telephone was an American invention and to the Western Electric Company belongs the credit for having the foresight in 1879 to lay the foundations for an enduring business in foreign lands.

At the present time it has associated companies in Belgium, Switzerland, Argentine, Norway, South Africa, England, Italy, France, Australia, Japan and Holland, and allied companies in China, Russia, Austria and Hungary.

The Western Electric Company played a prominent part in the Great War. It has been said by experts that the American army could not have functioned without the modern telephone system which was built in France between the front line and the sea coast. The multiplex printing telegraph was put to the test in handling the armies of the allies. In the air, the company did notable work in the development of radio telephony, particularly as applied to communication between airplanes and the earth; while on sea, in addition to the great practical utility of the public telephone from ships to the land, and from ships to each other, the submarine detecting equipment as developed by engineers both here and abroad undoubtedly was an inportant factor in defeating the submarine peril.

Apparatus was likewise developed for use in the locating of enemy artillery fire, and equipment for use in the listening posts, in advance of the lines.

In addition to its work on telephone apparatus, the company was able to serve the government in conspicuous fashion by assembling and shipping to the other side large quantities of electrical supplies of every character.

At the same time the foreign allied houses manufactured large quantities of equipment which were used by the allied armies.

Among the 12 Pleas Contained in the call-out of the steel strikers there is one not set forth by the union committees, but one which should not be lost underneath the turmoil resulting from the 12 original and specific requests. That it was necessary to use seven different languages, and even nine in one city, to communicate with the workers of this country is a decided call for more assistance in bringing to the foreign born of this country a thorough knowledge of the English language. In every community, however small, there is an opportunity for each person with a knowledge of English to add their tithe by teaching—individual, group, or class—the English that will put a member of the foreign-born legions into a position to grasp the essentials of pure American citizenship.

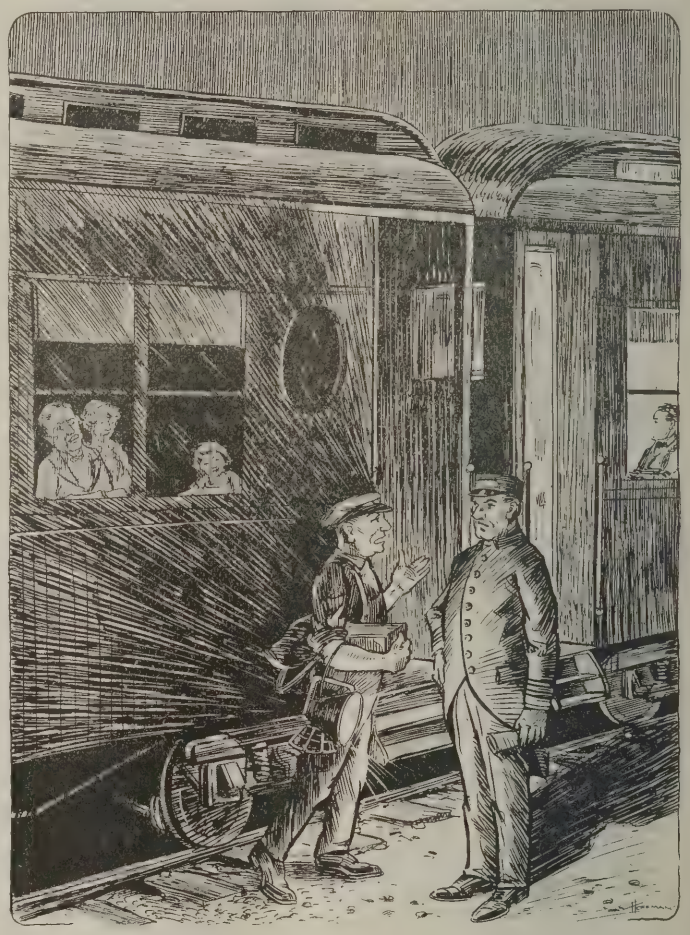
The Trials and Troubles of a Car Lighting Man

By Using Up All of the Conductor's Small Change Hinkey Dee Can Still Keep the Lights Burning

ELEVEN o'clock one night the boss hollered, "Hurry, Hinkey Dee! Rush job! Dynamite express will be here in four minutes with a car in darkness and I want you to do your best to get light on the car." Gosh, I feel good when the boss gives me a rush job because it seems to tell me I'm a wonder in car lightin' and I always says to meself, says I, "Hinkey Dee, your good." So I rushed in, grabbed me tools, lamp, hat, coat, gloves, book and me safety belt and runs as hard as I could to the station. I no more than reached the station when in rolled the train. I run from one end of the train to the other and found the car that was in darkness. I rushed up to the conductor and said, "What's the matter, Cap, lights out in this car" The conductor said, "You don't see any, do you? Are you blind or do you like to ask foolish questions?" I said, "I ain't got time to fool with you, I got me work to do and then I'll attend to you afterwards." So I run in the car and up to the switchboard and then I run out and got under the car and looked at the belt, then I run into the car and up to the switchboard, and then I run out and got under the car and looked at the wires to the generator; back I run into the car and looked at the switchboard and out again and got under the car and looked at the axle pulley; again I run into the car and up to the regulators, and again I run out and got under the car and looked at the generator pulley that's on the armature shaft; once more I run into the car and up to the switchboard and when I run out I fell over unconscious.

When I come to the train had left so I walked back and told the boss all about it. He said, "Well, did you look at the battery connections and the battery fuses?" "By golly, boss," I says, "I never once thought of that, I forgot all about lookin' at the batteries." "Your a bird," says the boss. "Ain't I dum?" says I. "No, your not dum," says the boss, "your worse than that. Hinkey Dee, when it comes to head work your there!" I felt kind of good when the boss said that because I always thought he knowed I was good at car lightin', but I didn't think he would come right out and say it.

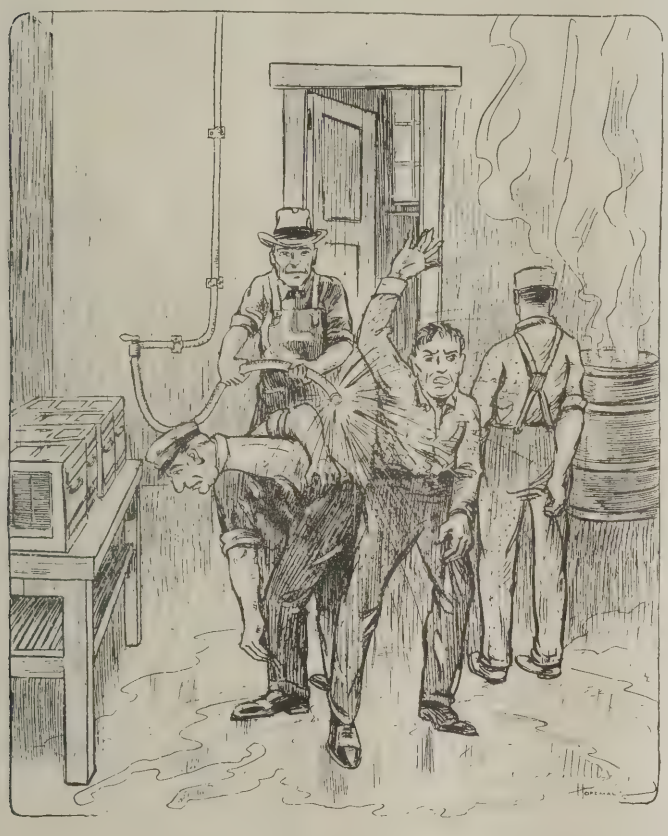
I walked out into the shop and sat down on a box. I no more than got comfortable when suddenly the door flew open and in rushed Eddie Ram. He said, "Hurry, Hinkey, the boss told me to tell you to run over and see what's wrong with the lights on car 44 on the Blue Bell." I said, "Right you be," grabbed me tools and yelled to Eddie that he had better come along as I might need him. We just reached the station when in comes the Blue Bell, and just as we got on it started again, so we had to go along. The train was jammed and we had to fairly force our way to car 44 which was on the head-end. In the rush and push I knocked some lady who was standin' in the aisle off her feet and she landed square on some feller's lap. She got mad, jumped up and started to scratch my face. I had both hands full of tools and let them drop. My tool box landed on some man's foot and broke his toe. His brother was with him and started to punch me. I



I rushed up to the conductor and said, "What's the matter, cap, light out on this car"? The Conductor said, "You don't see any, do you?" "Are you blind or do you like to ask foolish questions"?

sailed into him and Eddie helped me. Pretty soon the conductor came along and stopped the fight. The man with the broken toe was taken to the hospital and the lady told the conductor all about it. He told her that he'd have me attended to. Finally I reached car 44 without having any more fights and found the lights wouldn't lit. So I took out the plug fuses and tried them in another car and every single plug fuse was blown. So I opened me tool box and found twelve plug fuses. Everytime I put one in it would blow and pretty soon I had blown the whole twelve. Then I was stuck and I didn't know what to do. The conductor came along and asked me how I was makin' out and

I told him that all the fuses had blown and I had no more left. He said, "Goodness Gracious, man, you don't mean to say that I have to work the car tonight in darkness?" I says, says I, "Yes, that's what I mean, I don't know what can be done." All of a sudden I got an idea. I said, "Well, if I had some pennies I think I could get light." The conductor says, "Do you mean it?" I says, "Sure, I mean it." Then he pulled out a hand full of pennies and handed them to me sayin',



He washed us off so we wouldn't be eaten alive

"Help yourself, old top." I took a bunch of pennies and put them in back of the plug fuses so they'd close the circuit, and bing, they would melt up as fast as I could put 'em in. But when I got down to me last penny it held for fifteen minutes and the conductor was certainly pleased, when suddenly, Bang—out went all the lights. The conductor said, "Well, here's some more money, try your luck again." I tried some nickels and they lasted twenty minutes, but dimes lasted longer than any. Quarters and half dollars would not fit in so I had Eddie file them to fit, but they didn't last as long as dimes. I guess it was on account of being filed. The conductor didn't mind it at all, he said he had given me exactly $43.19 in pennies, nickels, dimes, quarters and halves, but it was worth it to have lights. So at the next station me and Eddie got off and the conductor got some more change so he could have more light.

On the way back home Eddie turned to me and said, "Good for you, Hinkey Dee, by Golly, you get some bright ideas. How do you do it, anyway?" I said, "Well, Eddie, it's this way, I never give up, no sir, I never give up! I stick to the finish. I know I'm good at car lightin' and that I have a good brain and a big head full of gray matter. I know nobody knows half as much as me about car lightin' and I work on that basis. Now, Eddie, if you want to be as good as me on car lightin, you'll have to brace up and put your shoulder to the wheel. Study all day and at nights, always studyin' and learnin somethin' then you'll gradually learn like me and can stop. But always remember, Eddie, never give up."

When we got back I told the boss all about it and he said it was a shame me and Eddie didn't work in a bank where there was lots of money for fuses. I didn't understand what he meant but I guess he meant I ought to be gettin' more pay for what I know. As a matter of fact I've been feelin' like that for some time. Between doin' me work, writin' these articles, and tryin' to educate Eddie Ram and Jimmy Goat I don't get half as much money as I'm worth. But I never give up. No, sir, I'm Hinkey Dee and I'll stick to the ship until she goes down.

My next job was to mix some acid for the boss. Jimmy Goat said, "The boss said he wouldn't let anybody mix any acid for him but Hinkey Dee." I guess that because he knows if Hinkey Dee mixes it it will be mixed right. So I said to meself, "If the boss wants some acid mixed I'm just the boy that can mix it." Then along comes the boss and said, "Say, Hinkey Dee, Jimmy Goat and Eddie Ram are cleaning a set of batteries and I would rather that you mix the acid for them. Take some of that 1800 acid and dilute it to 1220." I said, "All right, boss," and so I went and got a carboy of 1800 acid and dumped it into a big lead lined tank and then I got a bucket of water and poured it into the acid. Bing! Bang! The acid flew in all directions. Me, Jimmy Goat and Eddie Ram were covered with it and it started to bite. I run out of one door and in the other while Eddie and Jimmy followed after me. The boss heard the noise and came runnin' in and as soon as he saw us covered with acid he got busy with a hose. He washed us off so we wouldn't be eaten up. Soon as the acid stopped biting the boss told us we had better get other clothes on to be on the safe side. After we had new clothes on all the boss said was "Hinkey Dee, what did you fellers do that covered you with acid like that?" I said, "Well, boss, it was this way, me and Jimmy Goat and Eddie Ram dumped a carbody of 1800 acid into the lead lined tank and the acid must have been full of air because soon as we dumped the first bucket of water into the acid it exploded and here we are."

The boss laughed and said, "For Heaven's sake, do you mean to tell me that you don't know better than that, why you flat head you should have known better that that. Never pour water into acid, always pour the acid into the water." Jimmy Goat said, "Well, sir, I bet you I won't forget that in a hurry." Eddie Ram said,

"Bet I'll remember that." Then I said, "Yes, Boss, I did know all about that, that was what I thought, but Jimmy Goat and Eddie Ram brought me the acid in first and that's why it happened. But hereafter when they bring the acid first I'll send 'em back with it and have 'em bring the water first." Then, I says to meself, "I'll show 'em that I'm Hinkey Dee, the car lightin' expert. Guess I know how to mix acid and I'll show them a thing or two the next time, all right, all right." Then Eddie said, "Now, Jimmy Goat, which do you pour in —the acid in the water or the water in the acid?" "Let's see," says Jimmy, "I think you pour the water in the acid, but I'm not sure." Says Jimmy, "Say, Hinkey Dee, which is it now, do you pour the acid in the water or the water in the acid?" "You two blockheads," say I, "why you both got good memories, why me and the boss just about got through tellin' you to pour the water in the acid, didn't we?" "No, sir," says Jimmy, "didn't you pour the water in the acid when it blew up?" "Sure," says I, "that's what I say, always pour the acid in the water." "Then," Jimmy said, "why, Hinkey Dee, you just said to pour the water in the acid." Then I got mad. I said, "Now don't try to tell me what I said, I know what I said, I said, 'Pour the water in the acid' and that settles it." "All right, says Jimmy, "I don't want to raise a fight." Eddie Ram shook his head, "Yes" and we all went home, happy and satisfied.

Railroad Electrification Facts and Factors

A Comparative Discussion of the Various Methods Used in Accelerating Electric Locomotives

*By A. J. Manson**

IN THE two preceding articles we have described the control apparatus used on electric locomotives, and have discussed the general scheme of control, explaining that there are two electric circuits, namely, the main circuit and the control circuit. The main circuit consists of the motors, the resistance (in the case of the direct current) or the transformer (in the case of the alternating current) and the switch contacts, i. e., all of the connections and apparatus handling the main power currents. The control circuit consists of the wires, leading from the master controller to the various pieces of apparatus and switch magnet valves and to the receptacles and jumpers when operating double heading; these wires are generally energized from a 20 to 30-volt battery and carry only a fraction of an ampere.

Before describing the general construction of the types of motors used for locomotive work it is advisable to take up the different motor combinations. The number of the switches used and the interconnection of these switches will depend on the motor combination. While in general a direct current locomotive for operation on 1,200 or 3,000 volts will have the same motor combinations as those operating on 600 volts, still there are differences, so that we will refer to and discuss later this high voltage operation. The arrangement of motors for alternating current operation is still again different and will be considered separately. In locomotive operation where heavy trains are handled it is very necessary to have extremely smooth acceleration from start to maximum speed. The longer the train the more important it is to have smooth acceleration, otherwise surges will occur resulting in serious damage to couplers and drawbars.

*Westinghouse Electric & Mfg. Co., New York.

Direct Current Locomotive Control

We have all ridden in electric cars or trains and have noticed that there is a variation in the operation as far as smoothness is concerned. Take the trolley car for instance, the smoothness depends on the way the motorman handles the controller. If he uses care, fairly smooth operation will result, otherwise the acceleration may be too rapid and jerky. The acceleration of the street car is entirely in the hands of the motorman, as there are generally no automatic features to regulate the maximum amount of current. Such is the case with the electric locomotive. It has been the universal practice to consider the master controller as the throttle of the electric locomotive and to let the engineer regulate the amount of power to the motors, which is shown on electrical instruments provided for the purpose. Naturally the control apparatus is more elaborate than that used on the trolley car or elevated train, but the same fundamental principles are used. The arrangement of resistance and motors as generally used today is the result of several years of operation. There are many schemes of connections, all of which are feasible, but which have certain disadvantages. It is advisable to take up and discuss these various schemes so as to be perfectly familiar with motor and resistance combinations.

Subway and elevated trains use automatic regulation so that the rate of acceleration does not depend on the movement of the master controller but is taken care of automatically by a relay, set for some definite motor current value. While some of these trains operate very smoothly throughout the entire range of

the control steps from start to, say, 30 miles, and so on up to full speed, other trains of a different and older type will show a very decided change in speed. The train will operate smoothly up to, say, 15 miles per hour, then there will be a moment when the speed of the train will not increase but will perhaps even decrease slightly and then the train will accelerate again smoothly to maximum speed. This slacking off in speed and then a sudden pickup is very noticeable. While it is possible to operate this way with the elevated or subway train with only discomfort to

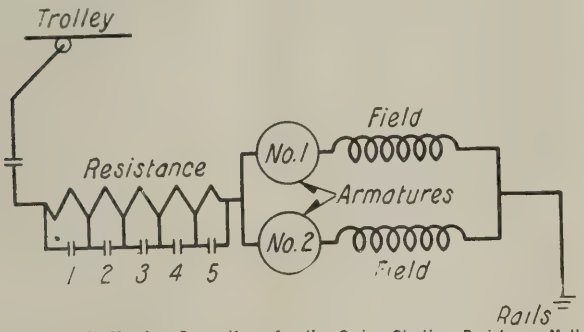


Fig. 1. Sketch Showing Connections for the Series Starting Resistance Method

the passengers, it would be impossible to have this variation in speed in the case of the electric locomotive on account of the damage caused by the surge.

There is, of course, a reason for this variation, and it comes down to the method used in changing the motor combinations so as to increase the speed. The latest method and one that is necessary for electric locomotive operation is known as the Bridging Method. Other methods have been used for elevated, subway and surface cars, namely, the Shunting Method and the Open-Circuit Method. Each of these methods will be discussed so that the subject of motor and resistance combinations will be clearly understood, although all of the schemes do not necessarily apply to the electric locomotive.

Full trolley voltage cannot be applied directly to the motors at standstill, as there would be an enormous current flow through them and they would develop an immense tractive effort. There would be great damage done, both electrically and mechanically. The motor when standing still offers only its ohmic resistance to the flow of current so that sufficient resistance must be placed in series with the motors to give the proper starting current. The resistance absorbs in the first point approximately 90 per cent of the voltage. Cutting out the resistance step by step increases the voltage at the motor terminals until full voltage is obtained.

Rheostatic Control—Series Resistance

There are several ways of connecting in the resistance. The easiest way and one which would mean the least amount of control apparatus, is to connect the motors permanently in the full-speed combination desired and then provide sufficient resistance. When all of the resistance is cut out, the motors are in the final arrangement and there are no combinations of motors in series and parallel. This arrangement is known as rheostatic control.

With rheostatic control the resistance connections may be connected in three ways, known as series resistance, parallel resistance and series-parallel resistance. With the series resistance, all of the resistance in the circuit is in series with the motors and it is gradually short-circuited by sections until the motors are connected across the full trolley voltage. The switches used to short-circuit the sections of the resistance are all open when the power is first applied. They are closed consecutively until all are closed. The arrangement is shown by Fig. 1.

Rheostatic Control—Parallel Resistance

In the case of parallel resistance, the resistance steps, as the name implies, are connected in parallel. Only a part of the resistance is in circuit at starting and this part will be of high resistance value so as to keep the current at normal value. Additional resistors are connected in parallel with the initial resistance until, on the last step, the entire resistance is short circuited. At each step when an additional resistance is added, the combined resistance is less, so that the voltage to the motors, and hence the current, is increased. This is according to the law of parallel

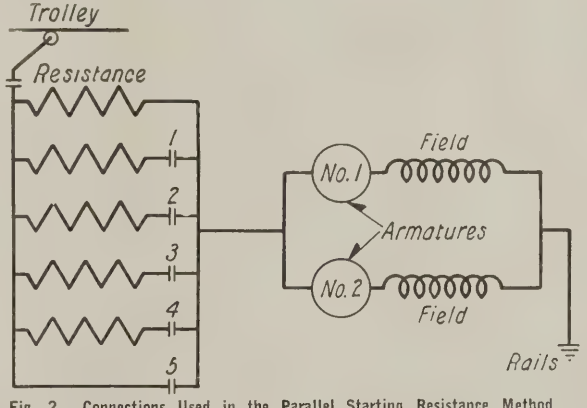


Fig. 2. Connections Used in the Parallel Starting Resistance Method

resistances. If we let R represent the joint resistance and r_1, r_2, r_3, etc., represents the individual resistance steps, then in the case of two resistances

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{r_2 + r_1}{r_1 r_2} \quad \text{or} \quad R = \frac{r_1 r_2}{r_1 + r_2}$$

The resistance of a parallel circuit can be put into the form of a rule as follows: "The joint resistance of a divided circuit is equal to the product of the two separate resistances divided by their sum." When the third step is brought in the same rule is followed.

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{r_2 r_3 + r_1 r_3 + r_1 r_2}{r_1 r_2 r_3}$$

$$R = \frac{r_1 r_2 r_3}{r_2 r_3 + r_1 r_3 + r_1 r_2}$$

The number of parallel resistances required depends on the value of each, but the joint resistance on the last

step must be low enough so that when the entire resistance is short-circuited the increase in voltage to the motors will not be greater than is necessary for smooth acceleration.

The arrangement is shown by Fig. 2. The switches *1, 2, 3, 4, 5* are all open at the start, the current flowing through the top resistance when the trolley switch is closed. Each switch is closed consecutively and when *5* is closed, the motors are operating on full trolley voltage.

Rheostatic Control—Combination Resistance

The third class of starting resistance mentioned above is a combination of the other two. The arrangement is shown by Fig. 3. The switches are shown as *1, 2, 3* and *4*. On the first step switch *1* is closed and all the resistance is in series. On the next step switch *2* is closed and *1* opened, so that part of the resistance has been cut out, leaving section *a b* in the circuit. Switch *3* is closed next and *2* is still left in. The section of the resistance *c a* cut out by the closing of switch *2* is brought back into the circuit by closing the switch *3*, but instead of being in series it is in parallel so that the joint resistance is less. On the next step switch *4* closes and *3* opens, so that the joint resistance is again reduced. The next step cuts out all of the resistance by the closing of switches *1* and *3*.

Motor Combinations

While in the above three arrangements smooth operation is obtained, there is a decided objection due to the arrangements not being economical from the power standpoint. With the motors connected permanently there is considerable power lost in the resistance. Economy can be obtained by connecting the motors in combinations, as less resistance is required and there is less loss in the resistance. Equipments include an even number of motors. For locomotive work the minimum

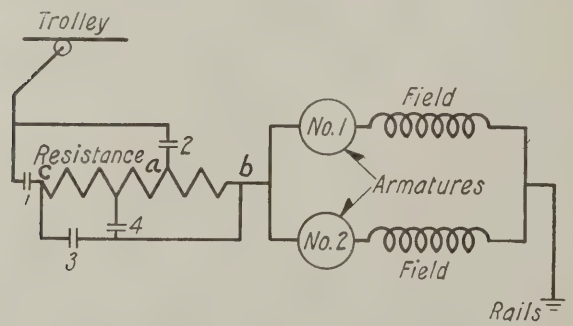


Fig. 3. The Combination Series-Parallel Starting Resistance Method

number is generally four and may be as high as design permits, although the large and powerful locomotives operating out of the Pennsylvania terminal, New York, have only two motors. To gain the maximum saving in power consumption the combinations will be as shown by Fig. 4, the motors being connected first in series, then in series parallel and finally all four in parallel.

In small locomotives of 60 to 80 tons or less the first or "series" arrangement with the four motors in series, is generally eliminated so that the locomotive starts with the motors in the series-parallel arrangement. Two motors are connected permanently in parallel and are controlled as one unit.

With motor combinations the problem of changing from one to the other, still obtaining smooth acceleration is somewhat different than with series resistance, Figs. 1, 2 and 3. With rheostatic control the circuits are simple. All that is necessary is to arrange the circuits as shown by the diagrams and provide a means

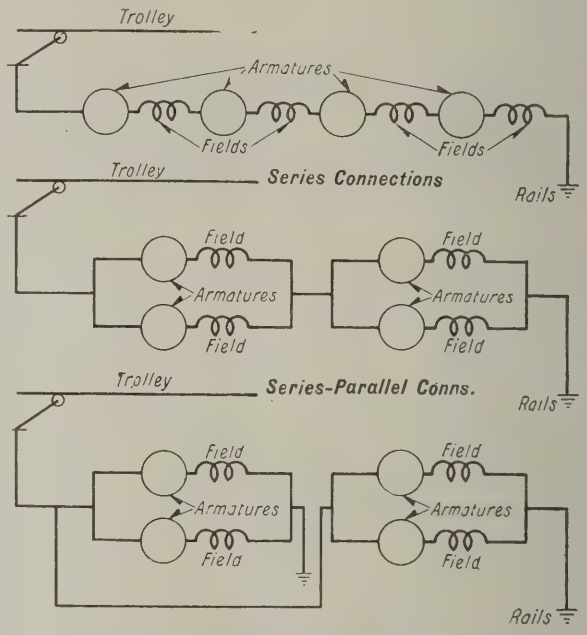


Fig. 4. Complete Motor Combinations

for cutting out the resistance. With the motor combinations, means must be provided to make the transition from series to parallel.

Transition Methods

There are three methods used in changing the motors from series to parallel, namely:

(a) Open circuit method.
(b) Shunted motor method.
(c) "Bridging" method.

These three methods are listed in the order as developed and brought out. The "bridging" method is the latest developed and the smoothest in operation, while the open circuit method was the first and the roughest. It might be added that the development of the transition methods did not occur with electric locomotives, but with elevated and subway multiple unit trains as well as with trolley cars.

Open Circuit Transition

The open circuit method is shown in Fig. 5. On the transition step the connections between the motors and the trolley are broken or "open-circuited." The motors are therefore developing no torque during the short time that the circuits are changed so that the

motors will be in parallel when the trolley connection is made again. The speed falls off and there is naturally more or less of a surge when the power comes on again. This arrangement or method would not be satisfactory for locomotive operation as surges are not allowable. Referring to Fig. 5, the switches closed for full series operations would be *T*, *1*, *2*, *3*, *4* and *5*. To get the two motors in parallel switch *T* is opened and then switch *5*. Switches *6* and *7* are

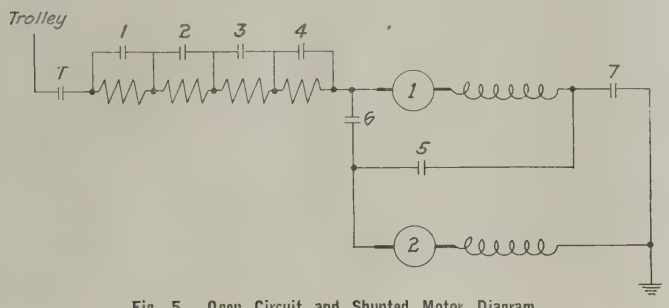


Fig. 5. Open Circuit and Shunted Motor Diagram

then closed, the two motors connected in parallel, and then switch *T* closes with the correct amount of resistance in series.

Shunted Motor Transition

The same diagram, Fig. 5, will show the shunted motor method. The full series will be the same as the open circuit arrangement. Instead of opening the switch *T* and cutting off the power, the switch is left in. Part of the resistance is cut in again by the opening of switches *2*, *3* and *4*, and an instant later switch *7* is closed, connecting the power passing through the No. 1 motor directly to ground. The current is cut off from the No. 2 motor—it is "shunted" away—so that the No. 2 motor is short-circuited. Switch *5* is opened and switch *6* is closed, which puts the No. *2* motor in parallel with the No. *1* motor. The resistance is again cut out step by step and the motors are in full parallel. This method has a distinct advantage over the previous method in that only one-half of the torque is lost during transition instead of all.

"Bridging" Transition

The "bridging" method is quite different from the other two. The current is not cut off from either motor, nor is either motor short-circuited or shunted. This method has an advantage over both of the others, in that both motors are working all the time and none of the torque is dropped during the transition period. Smooth operation is thus obtained throughout the whole acceleration. The arrangement of the circuits is as shown in Fig. 6. It should be noted that a different notation has been used for the switches. The notation used is much better than numbering, as each has a certain signification. For instance, *L S* stands for "line switch". These switches are directly connected to the trolley or source of supply and the closing of them connects the current through to other switches and the motors. When the motors are running the opening of these switches will cut off all power. While *S* has no particular meaning, the resistance which it cuts out is a series resistance only, that is, it is used only with the motors in series and is generally short-circuited by the closing of the switch *S* on the second notch of the controller. *R* stands for resistance and so R_1, R_2, R_3 and RR_1, RR_2 and RR_3 are resistance switches and are used to cut out the resistance. The letter *J* could signify "jumper". The switch *J R* when closed completes a jumper connecting the two motors in series outside of the two sets of equal resistances. The switch *J* when closed completes a jumper, connecting the two motors directly together with the resistance out of the circuit. Referring to Fig. 6, the sequence of switches is as follows: On the first step the switches *L S 1* and *J R* are closed, thus putting the motors in series and all of the resistance in the circuit. The current flows through *LS1, S-Resistance, No. 1 motor, 1 Resistance* through *JR2 Resistance, No. 2 motor,* to ground. On the next step, switch *S* closes and the motors begin to pick up. The switches R_1, RR_1, R_2, RR_2, R_3 and RR_3 are closed consecutively as the controller is thrown from notch

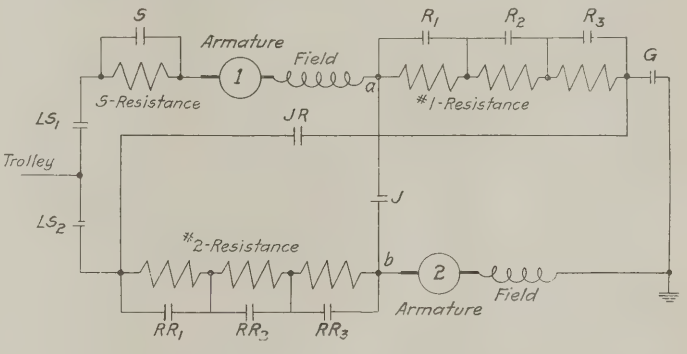


Fig. 6. Bridging Method Diagram

to notch and switch *J* is closed. After the switch *J* is closed all of the resistance switches for the *1* and *2* resistances open and the motors are in series, the current flowing through switches LS_1, *S* and *J*. The bridging is now arranged. Switches LS_2 and *G* are closed. For a moment disregard the motors. There is then a circuit from the trolley through LS_2, *2 resistance, J 1 Resistance* and *G* to ground. There are thus established two circuits through the switch *J*, which are in opposite directions. The resistances are of such a value that when placed across the line the flow of current will be the same as that taken by the motors at the speed which the locomotive is moving when the change is made from series to parallel. If the two currents are equal there will be no current passing through *J* and it can be opened without notice. Of course it is practically impossible to have the *J* switch open at the exact time when the current is zero. The current flowing through the motors and through the switch *J* in the direction *a* to *b*, will depend on the speed of the locomotive. The back electromotive force of the motors increases with the speed and the current is reduced. On the other hand the current through

the resistances in series is always the same. Therefore, if the engineer waits too long before proceeding to parallel, the current through the resistances will be greater and the switch J on opening, will break a current flowing from b to a. If the speed is too low the extra current will flow from a to b. The opening of the switch J establishes two parallel circuits, one motor in each circuit with its resistance in series. The resistance switches are progressively closed as in the series position, except that corresponding switches in each set of resistance close together, for instance R_1 and RR_1 and the motors are operating at full voltage. With the "bridging" method the motors are started connected in series with the resistance and are brought up to a full parallel without at any time having the torque changed more than that due to the cutting out of one resistance step.

In the next article the different methods or arrangements of resistance and motor combinations will be discussed from the question of economy and power consumption.

EFFICIENT LAMP MAINTENANCE

The development of industrial illumination has reached a point where it will be profitable to pause a moment to consider what has been accomplished, and what remains to be done.

In the first place, let us realize that successful industrial illumination depends upon two factors:

1. The development of an efficient lamp.
2. The manner in which it is handled by the user.

The failure of either of these two factors prevents the successful functioning of the other.

It is quite apparent that the manufacturers of the bulbs, and the manufacturers of reflectors, have spared no effort or expense in the development of these two component parts of the modern industrial lamp—it is a wonderfully efficient piece of apparatus, and the manufacturers are to be congratulated on their marvelous achievement.

But after the manufacturers have done their utmost, the user is going to be sorely disappointed in the results obtained unless he squares himself with the functions that necessarily must devolve upon him.

Naturally the first consideration to command his attention is the selection of the proper type of lamp for the service required of it—then the mounting height and spacing. On all three of these subjects he may obtain valuable suggestions from the lamp manufacturers, because they have given these matters particular study in the development of the lamps.

But from this point on, the success of the installation must depend entirely on the degree of maintenance it receives at the hands of the user. As maintenance depends solely on the human factor—nothing else—it would seem most appropriate to study that human factor with the view of determining just what can be done to procure from it the desired results.

For instance, we are all familiar with the natural human tendency to neglect or avoid any work that is attended with difficulty or danger, so instead of installing the large high lamps, for general illumination, where they are more or less difficul or dangerous or awkward to get at, and having the maintenance neglected, would it not be far better to do it just the other way around—make them easy and safe of access? Wouldn't we be much more likely to get the results we want to get?

So far as most of the large high lamps are concerned, probably the most appropriate way to make them easy and safe of access is to install them on a disconnecting hanger—a device that has been developed expressly for the purpose of facilitating the cleaning and care of large high lamps in and about mills and shops.

By the use of this device the lamp can be lowered to the ground for cleaning, without any long dangling loops of wire to come down with it. The lamp simply drops away from the circuit when lowered leaving the wiring undisturbed, enclosed if desired. When the lamp is pulled up again it goes automatically back into the circuit and locks.

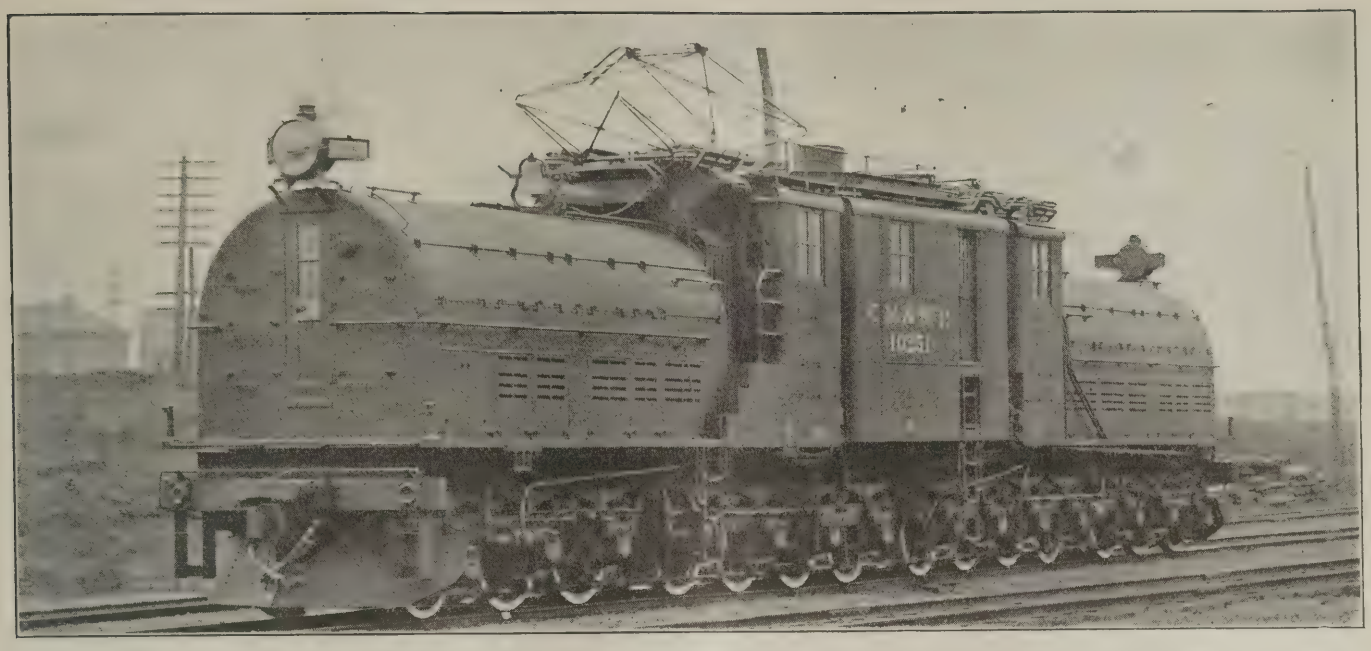
This method of installing the large high lamps has already been adopted in many large industrial plants, railroad shops, etc., and the results have been so satisfactory that the practice is rapidly growing.

The point is, the lamp having been developed to a high degree of efficiency, it is important now that we turn our attention to means for maintaining that efficiency in service.

The responsibility for this rests solely with the user, and his shortest cut to success is to adapt the job to the average man, rather than to try to make over every new man to suit the job—it makes discipline just that much easier to maintain.

THERE MUST BE AN END.—It is not a railroad man, but a member of the Interstate Commerce Commission, Mr. Clark, who has told the House Committee that the raising of freight rates is inevitable. Time was when the Commission conceived it to be their duty to oppose every application of the railroads for higher rates. Mr. Clark believes the high wages will have to be maintained. The suggestion that the Commission be given power to fix wages he earnestly repelled. Not for the Commission the job of cutting wages to meet income! There remains only the universal last resort—to make up the deficit out of the pockets of the public. This process is now world-wide. But there must be an end to it some day. English miners, fearing the effect of public feeling regarding their pleas for shorter hours and higher wages, have asked the Government to suspend the order until they have had a chance to show that it may not be necessary. "Strike and the world strikes with you; work and you work alone."—*New York Evening Post.*

SEVEN YEARS AGO a farmer hung his vest on a fence post by the barnyard. A calf chewed up part of the garment, including a pocket in which was a standard gold watch. Last week the animal, a staid old milk cow, was butchered for beef, and the timepiece was found in such a position between the lungs of the cow that the respiration—the closing in and filling out of the lungs—kept the stemwinder wound up so that the watch had lost only four minutes in the seven years.



C. M. & St. P. Electric Locomotives Tested at Erie

Five Units of This Type Will be Used in Passenger Service Over the Cascade Electrified Section

TESTS were made on one of the five electric locomotives built by the General Electric Company for the Chicago, Milwaukee & St. Paul at Erie, Pa., on Friday, November 7. The large number of nationally prominent engineers and railroad men present at the demonstration was evidence of the interest taken in the subject of electrification. The representation included 11 American railroads, two Canadian railroads, the Chilean Railway Commission, manufacturers from the United States, France and Japan, several consulting engineers and representatives of the General Electric Company from various parts of the world. All of those present were guests of the General Electric Company.

During the morning a number of speed runs were made along the three-mile test track. Two passenger cars were hauled on some of these runs and some were made with the locomotive running light. The runs were continued until everyone had had an opportunity to ride on the locomotive. It was particularly interesting to note that practically all of the railroad men who rode in the cab of the locomotive, underestimated the speed. A speed of 60 miles an hour was estimated usually at about 45. A buffet luncheon was served in one of the shop buildings at noon.

In the afternoon tests were made to show what could be done with regenerative braking. Two New York Central steam locomotives were brought onto the test track. One of these was a (4-6-2) Pacific type and the other a (4-8-2) Mohawk type. These were coupled in tandem to the electric locomotive and used to push it while the electric locomotive was made to regenerate electric power to the trolley and thereby resist the power of the steam locomotives. The steam engineers were instructed to use all the power they could, but it was possible with both steam locomotives working to full capacity to hold the speed down to any desired value by regenerating with the electric. The noise of the exhausts was good evidence of the fact that reverse levers were left in the extreme forward position and that throttles were wide open. A measurement of just what the steam locomotives were doing was obtainable in the substation where the meters showed that the electric locomotive was returning 1,200 amperes at 3,000 volts, or almost 5,000 hp. of electrical energy to the power system. This was done at a speed of about 25 miles an hour. When pushed by another electric locomotive, one of these engines has returned as much as 1,600 amperes to the line.

After a number of regeneration tests had been run all of the observers were taken in a train hauled by an oil-electric locomotive to a point near one end of the test track where a tug-of-war test was made. This part of the track was used because of the possibility of damaging rails by slipping drivers. The three units were coupled as before and at a given signal the steam locomotive engineers started to push the electric locomotive and the driver of the electric started to push against them. The steam men showed some very expert handling in this test and neither one slipped the drivers of his engine. At first the steam locomotives were allowed to push the electric a short distance. Then additional power was applied to the electric until the steam locomotives were pushed

slowly backward. This was repeated several times. Comparative data for the two locomotives is given in the table. The local weights given for the steam locomotives do not include the tender.

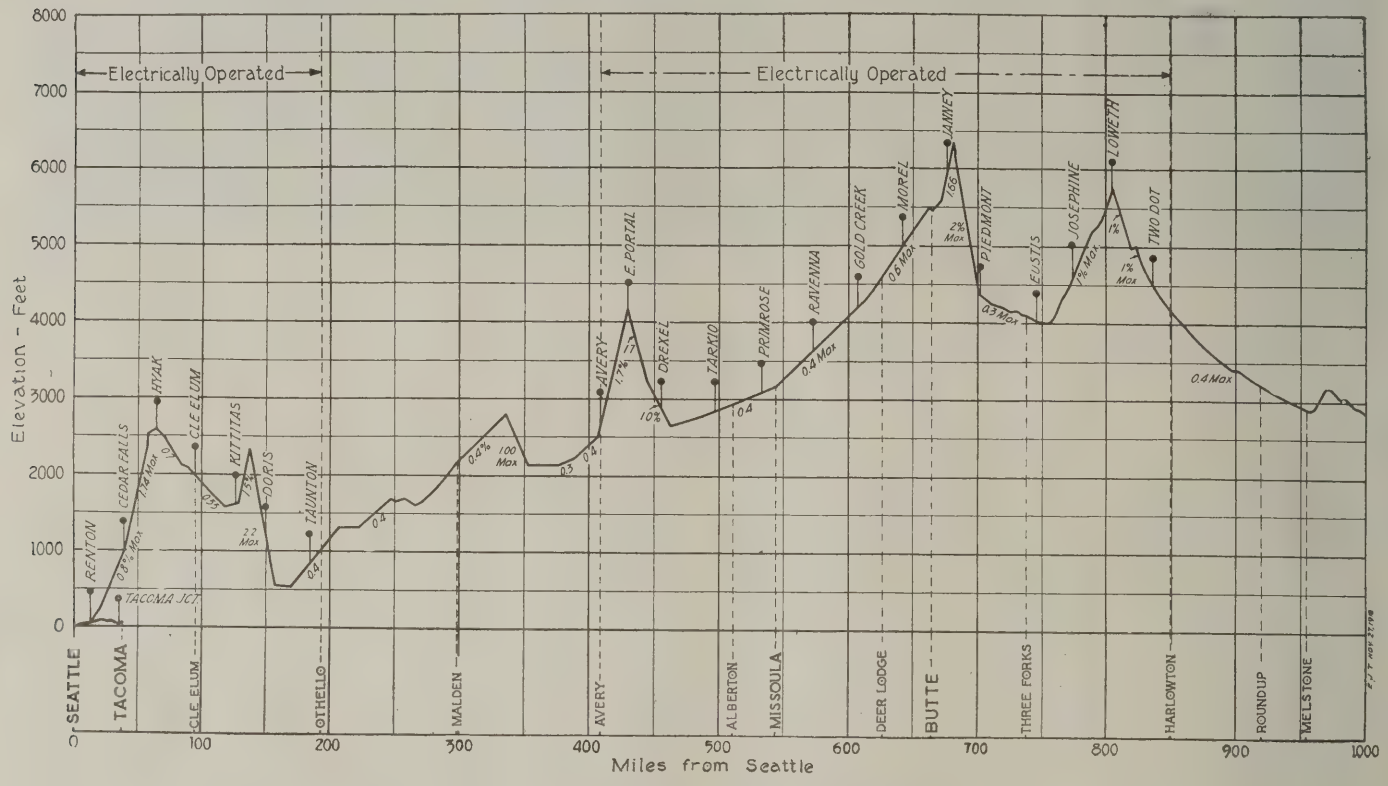
	Pacific	Mohawk	Electric
Total weight, lb	273,000	343,000	530,000
Weight on drivers, lb	173,000	234,000	458,000
Weight on each driving axle, lb	57,667	58,500	38,167
Diameter of driving wheels, in	72	62	44
Size of cylinders, in	22 x 28	28 x 28	
Number of drivers	3	4	12

From the data in the table it may be seen that the total weight on drivers of the electric locomotive is 51,000 lb. greater than that of both steam locomotives. For this reason the test did not illustrate the fact that greater adhesion is possible with the electric locomotive because of uniform torque. On the other hand, as the total weight of the steam locomotives is 86,000 greater than that of the electric it afforded unmistakable evidence of the greater amount of power which can be delivered to the rails by an electric locomotive as compared with steam locomotives of the same weight. The test also showed the ease with which an electric locomotive can be controlled, and illustrated the possibilities of regenerative braking in a manner to convince the most skeptical.

Five of these electric locomotives will soon be completed and placed in operation for passenger service on the Othello-Seattle-Tacoma electric zone of the Chicago, Milwaukee & St. Paul. They are of the 3,000-volt direct current, gearless type.

The original electrification from Harlowton to Avery, 440 miles, has now been operating for a number of years under the bad weather conditions common to the Rockies and Bitter Root mountains. It is significant, therefore, of the success of the original installations, that the same system will now be used to meet the severe grades and snow conditions of the Cascade range.

The motive power now in service on the eastern electrified section consists of 42 locomotives for freight and passenger service and four switchers. Of this original equipment, the freight and passenger locomotives were practically the same and differed from each other only in the gear ratio between motors and driving axles.



Profile Showing the Two Electrified Divisions of the Chicago, Milwaukee & St. Paul

The new locomotives are of an entirely different design, built distinctively for passenger service and possess some very interesting mechanical and electrical features. They will be used on the new Cascade electrification strictly for passenger service, and the passenger engines will be adapted for freight service by changing the gear ratio. The locomotives are of the bi-polar gearless type, with motor armatures mounted directly on the driving axles. In this fundamental feature they follow the design of the gearless locomotives in use on the New York Central. The principal advantage of this method of construction is the simplicity of mechanical design, which eliminates gears, armature and suspension bearings, jack-shafts, side-rods, or other transmitting devices.

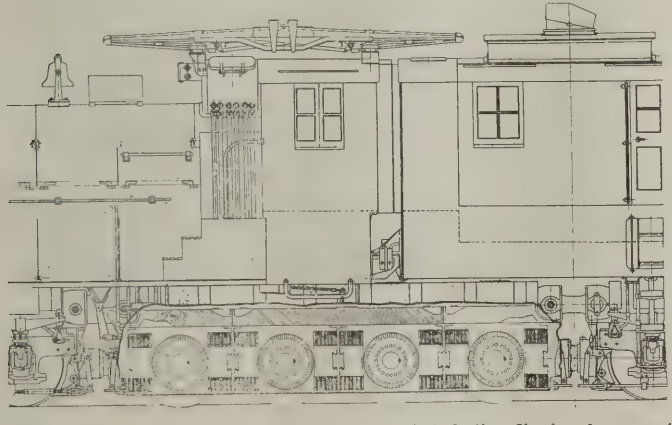
The new locomotives weigh 265 tons with 229 tons on drivers. They have 14 axles, 12 of which are driving and two guiding axles. The weight of the armature and wheels is the only dead weight on the track, and this is approximately 9,500 lb. per axle. The total weight on drivers, 458,000 lb., is 86 per

cent of the weight of the locomotive, which, being distributed among 12 axles, results in a weight of only 38,166 lb. per axle.

One of the most interesting and important features of the locomotives is the design of the leading and trailing trucks and the method of suspension of the cab weight upon them. The successive trucks are coupled together in such a way as to dead lead or break up any lateral oscillation which may be caused

Two Steam Locomotives Used to Supply Power which was Regenerated to the Trolley by the Electric Locomotive

by inequalities of the track. The weight of the main cab is so supported on the front and rear trucks that any lateral thrust or kick of the leading or trailing wheel against the track is cushioned by the movement of the main cab, which increases the weight bearing down on the wheel at the point where the thrust occurred, and automatically reacts to prevent any distortion of the track. The result of this design is such as to give particularly good riding qualities at high speed. Exhaustive tests have demonstrated the remarkable riding qualities of the new locomotives at speeds as high as 65 miles an hour, which was the maximum speed permissible on the length of test track available. These tests also indicated that the

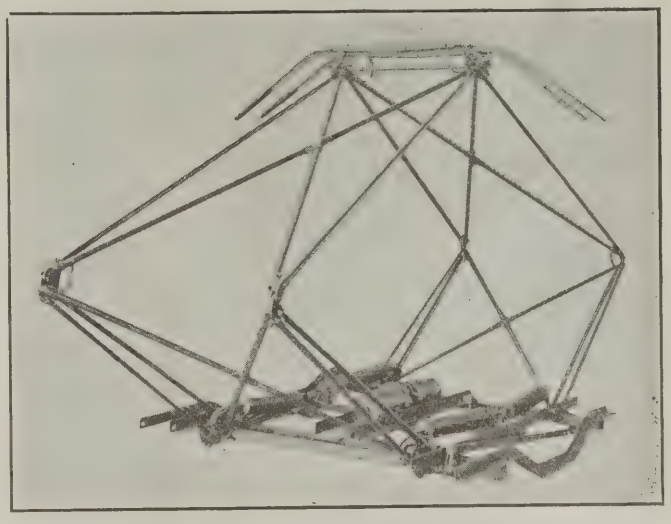


Side Elevation of Portion of Locomotive with Vertical Section Showing Arrangement of Armatures, Axles and Motor Fields

locomotives will operate at higher speeds with equal success.

The locomotive is designed for handling in normal service a 12-car train, weighing 960 tons trailing, against a grade of 2 per cent at 25 miles an hour. This performance requires 56,500 lb. tractive effort which is equivalent to a co-efficient of adhesion of 12.3 per cent of the weight upon driving axles. The wide margin thus provided between the operating tractive co-efficient and the slipping point of the wheels, as well as the ample capacity of the motors, will allow this locomotive to haul trains with as many as 14 cars in emergency. For continuous operation the locomotive is designed to operate at 42,000 lb. tractive effort at a speed of 27 miles an hour.

The total weight supported on driving axles is practically the same as that on the present geared passenger locomotives, weighing a total of 300 tons. The



Type of Two Contact, Slider-Pantagraph Used on New Locomotives

table gives the principal dimensions, weights and capacity of the gearless locomotives.

Weight electrical equipment	235,000 lb.
Weight mechanical equipment	295,00 lb.
Weight complete locomotive	530,000 lb.
Weight on drivers	458,000 lb.
Weight on guiding axle	36,000 lb.
Weight on each driving axle	38,166 lb.
Number of motors	12
One hour rating	3,240 hp.
Continuous rating	2,760 hp.
Tractive effort—one hour rating	46,000 lb.
Tractive effort—continuous rating	42,000 lb.
Tractive effort—two per cent ruling grade with 960-ton train	56,500 lb.
Coefficient of adhesion ruling grade	12.3 per cent
Starting tractive effort—25 per cent coefficient of adhesion	115,000 lb.
Rate of acceleration starting two per cent ruling grade	0.48 m.p.h.p.s.
Length inside knuckles	76 ft. 0 in.
Length over cab	68 ft. 0 in.
Total wheel base	67 ft. 0 in.
Rigid wheel base	13 ft. 11 in.
Diameter driving wheels	44 in.
Diameter guiding wheels	36 in.

Motors

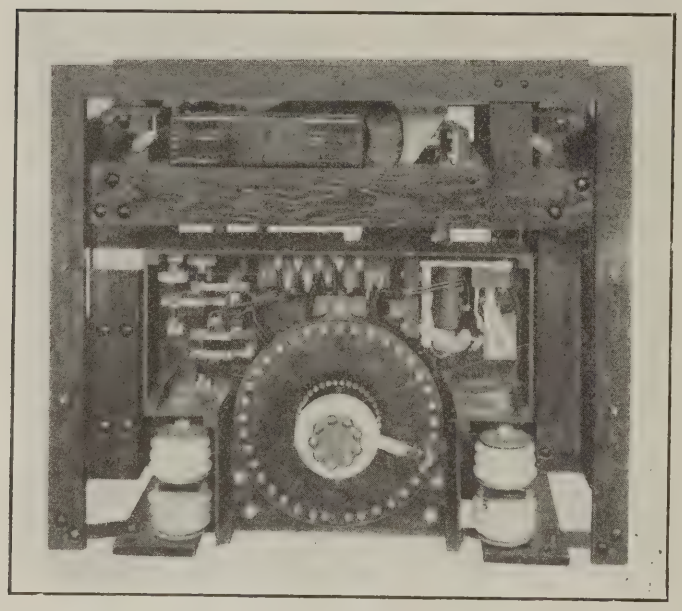
The motors are bi-polar, the two fields of each being supported upon the truck springs with full freedom for vertical play of the armature between the pole faces. The armatures are mounted directly on the driving axles. For full speed operation, the 12 motors are connected three in series with 1,000 volts per commutator. Control connections are also provided for operating four, six or twelve motors in series. Additional speed variation is obtained by tapping the motor fields in all combinations.

Regenerative electric braking on down grades is obtained by using four of the motors as generators

to supply exciting current for the other eight, which then return power to the trolley. This reduces the size of the motor-generator set required for control, accessories and train lighting, and thereby effects an appreciable reduction in the weight of control equipment.

Secondary Apparatus

Cooling air for each pair of motors is supplied by a small motor-driven blower. This arrangement avoids the heavy duct losses encountered with a single large



Side View of High Speed Circuit Breaker with Covers and Arc Chute Removed

blower. The six blower motors may be operated six in series, or in two groups of three in series, thus allowing for two rates of cooling for the main driving motors.

The center cab is occupied by an oil-fired steam boiler for heating passenger trains and with accessories, including tanks for oil and water, circulating pumps and a motor-driven blower for furnishing forced draft. This center portion of the cab can be lifted out in case the steam boiler is in need of heavy repairs.

In the curved end of one of the cabs is located a small motor-generator set operating in conjunction with an 80-volt storage battery in the other cab, which supply power for operating switches, contactors, lights and accessory apparatus. The battery is, in general, similar to those used on the passenger coaches. In the cab with the storage battery are also the 3,000-volt contactors and grid resisters and an air compressor driven by a 3,000-volt direct current motor. The high speed circuit breaker is placed in the cab which contains the motor-generator set.

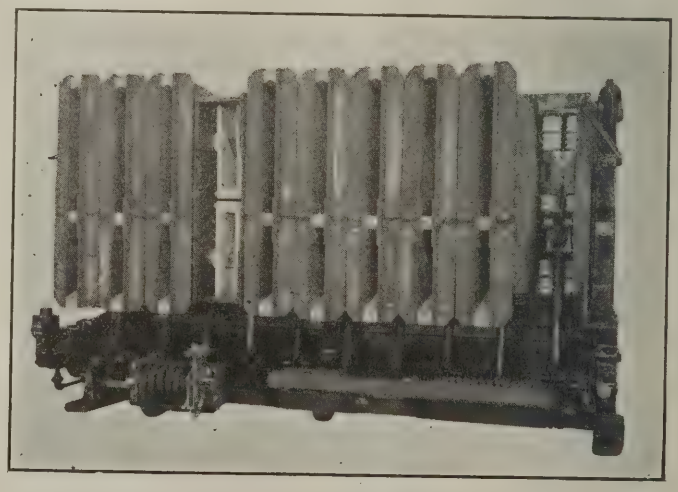
Power for train lighting is obtained from the motor-generator set. A switchboard located in the operator's section of one of the cabs is equipped with switches, resisters and meters for controlling the train lighting set. The head end system of lighting is in use on the St. Paul trains over this division. In the other operating cab there is a small motor-driven air compressor, operated from the battery circuit, with sufficient capacity for raising the pantograph when first putting the locomotive in operation.

A slider pantograph, similar in construction to those now in use, is mounted on each of the operating cabs. This pantograph has two sliding contacts, giving a total of four on the slider with a double trolley. The pantograph and flexible twin trolley construction enable the locomotive to collect current as high as 2,000 amperes at speeds up to 60 miles an hour without noticeable arcing at the contact points. The second pantograph is held in reserve as a spare. Sand boxes, with pipes leading to each pair of driving wheels, are located directly beneath the pantographs outside of the operating cab.

Control

The driving motors are controlled by a reverser handle and two control handles. Within reach of the driver are also the straight air and automatic air brake valves, the sander, the bell ringer, several meters to show what the locomotive is doing, and a number of switches for the headlight, the cab lights, the cab heater, etc. The control handles are mechanically interlocked to prevent incorrect manipulation.

The meters indicate line voltage, speed, line current and field current. The needle of the ammeter which registers line current will swing in either direction and show how much current the motors are using or how much they are regenerating to the trolley. The ammeter which registers field current resisters from zero to 400. The meter scale is black from zero to 200 and red from 200 to 400, to indicate to the operator that he

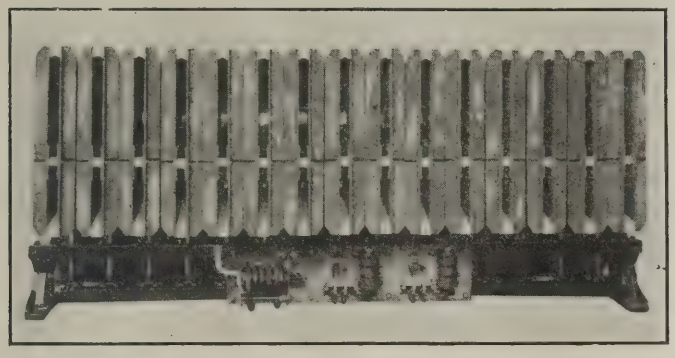


Series-Parallel Switch Group. These Switches are Air Operated

must not run continuously with values of field current in excess of 200 amperes.

The diagram shows a profile of the road from Seattle to a point about 1,000 miles east, including the Cascade electrification, the Harlowton-Avery electrification and the intervening 220 miles. The new locomotives will operate over the section between Othello, Seattle and Tacoma, including 17 miles of 2.2 per cent grade from

the Columbia river west, and 19 miles of 1.7 per cent grade between Cedar Falls and the summit of the Cascades. The traffic over this division consists of the heavy main line transcontinental passenger trains "Olympian" and "Columbian", carrying from eight to twelve steel passenger coaches, which will be handled over the maximum grade without helpers. Freight



Resistance Control Contactor Group. These Contactors are Solenoid Operated

pushers are already in operation on the 2.2 per cent grade, using two of the locomotives from the original electrification. It is expected that electrical operation during the coming winter will assist in overcoming many of the delays which are commonly met with during winter operation in this district.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CONDUCTS CAMPAIGN FOR ENDOWMENT FUND

What would the engineering profession do without technically trained men? The Massachusetts Institute of Technology recently launched a $10,000,000 Endowment Fund campaign. Back of all its appeals the fundamental argument of the M. I. T. is that she is producing the competent technical experts that the country needs year after year.

The research division of the electrical engineering department is an important factor in the department and has done some admirable work. For example, an exhaustive report of "Experimental Researches on the Skin Effect in Steel Rails" was brought out in 1916 by A. E. Kennelly, Sc.D., professor of electrical engineering at the institute, and F. H. Achard and A. S. Dana, research assistants. The research originated from a Technology student's thesis, and was conducted under an appropriation from the American Telephone & Telegraph Company. Its objects were to determine, by direct measurement, the impedance offered to alternating currents of the strengths likely to be employed in the electric-railway work by standard steel rails of various shapes and sizes; also to ascertain how this impedance varied with frequency and with current-strength, and whether the impedance could be reduced to a sample engineering theory, so as to admit of being predicted within reasonable limits from physical data concerning the steel used in the rails.

Tests were extended to 11 sample track rails and 2 sample contact rails, 10.07 metres in length, ranging in linear mass from 30 to 50 kilograms per metre, with corresponding cross-sections from 38.5 to 64.5 square centimetres. Three frequencies were used in the tests, namely 25, 45 and 60 cycles per second, the bulk of the work being carried on at or near 25 and 60 cycles. The current-strengths employed in the test rails varied from 10 to 800 amperes. The test circuit was constructed to make the measurements as nearly as possible under practical railway conditions. The results were very interesting and represented a marked advancement along this line. The report was published by the Journal of the Franklin Institute and in separate pamphlet form. This is typical of the work being done by the research division.

During the war the electrical engineering department of the institute furnished 25 men from its staff either to military service or associated government work.

Technology has hundreds of graduates in active service with railroad and street railway companies. John S. Blecker, '98, is general manager of the New Orleans Railway & Light Co.; William Rawson Collier, '00, is sales manager of the Georgia Railway & Power Co. and manager of its electrical department. William Babcock Poland, '90, was vice president and chief engineer of the Philippine Railway Co. and later chief engineer and general manager of the Alaska Central Railway Co. Matthew Brush, '01, was president of the Boston Elevated Railways and successful in his striking policy of putting the road under public control. Samuel Morse Felton, '73, the president of the Chicago Great Western, at the head of 12,000 railroad engineers reorganized the shattered railroad systems of France. These are only a few of the many Tech men with whose achievements the readers of the *Railway Engineer* are familiar.

This is a time for expansion in American industrial projects. Technology wants to keep her place among the leaders in technical training. The industries want Tech men. Tech can produce the men only if she has the money. Tuition fees cover just one-third of the annual budget in spite of the fact that the tuition fee is now the largest in the country. The logical solution lies in an Endowment Fund. A mysterious friend of the Institute, realizing this, has promised $4,000,000 provided another $4,000,000 is pledged by alumni and friends. This individual prefers to remain unknown, and is generally referred to as "Mr. Smith". He is reported to be an industrial leader of large wealth who is not a Technology graduate, but who has a vital interest in technical education.

PRACTICAL STUNTS

An Indicating Battery Flushing Outfit

By G. W. Miner, Cleburne Shops, Cleburne, Texas

In the two photographs which follow is shown a battery flushing outfit which possesses the advantageous feature of indicating when the battery is flushed. As may be seen, the water is brought to the battery in a barrel mounted upon a U-shaped axle which in turn is supported by two mail-cart wheels. A circular piece of wood having a diameter

Portable Outfit for Flushing Batteries

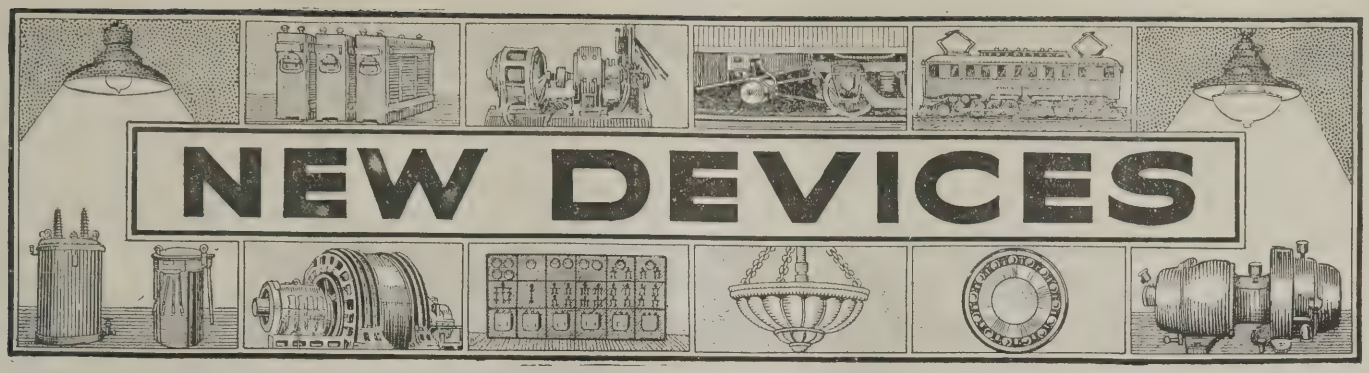
equal to the head of the barrel within the staves is fastened to the axle and one end of the barrel rests upon this platform. The barrel is further secured by a strap attached to the axle just below the hub of the wheels. Any kind of a suitable handle can be applied.

With this type of outfit a force pump is required and in this particular instance an old coach pump, such as is used in old style Pullman cars, was used. The holes in the cap and in the top of the pump were soldered shut and the cap soldered to the pump. The cap was then drilled and tapped for a ⅜-in. pipe bushing which was reamed out to fit the pump rod. This makes a packing box which when packed with wicking completes the force pump. The next step was to saw off the copper pipe two inches below the pump cylinder and attach a piece of hose long enough to reach within one inch of the bottom of the barrel. The pump was then fastened to the top of the barrel with brass screws. Under no circumstances should iron screws be used for this purpose. A piece of ½-in. hose, 12 ft. long was next attached to the pump spout, the other end of the hose being connected to a piece of ½-in. copper pipe, 6 ft. long. About 2 in. from the end of this pipe a piece was cut off at an angle of 45 deg., the short piece thus obtained being turned about and soldered to the end of the pipe in such a way as to form a right angle bend. To this short piece of pipe a copper washer about 1½ in. in diameter was soldered on, about 1 in. from the opening of the pipe. By this means the depth to which the tube or pipe extended into the battery was controlled.

The indicating feature was obtained by the use of a 16 or 25-watt tungsten lamp. This lamp was mounted in a metallic socket connected at the other end of the copper pipe. One terminal of this socket

The Outfit in Service Showing the Indicating Lamp

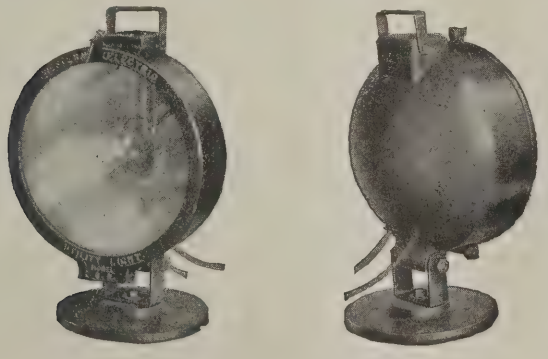
was grounded to the pipe and the other terminal connected to a lead long enough to reach any other cell in the battery. When a cell was full the lamp would light indicating that sufficient water had been pumped in. I have found this outfit to be the best and quickest way of flushing batteries.



A New Portable Utility Light

A new type of night light for highly localized lighting has recently been placed on the market by the Western Electric Company. This light, which is to be known as the Western Electric Portable Utility Light, is for use at close ranges where the light is to be located at distance not greater than 125 feet of the object or surface to be illuminated.

With the light operating on a 100 feet throw, a 100-foot spread is obtained at an angle of sixty degrees.



Front and Rear View of Lighting Unit

The unit gives a smooth white light without gleam or glare. This is made possible by a new development—the hammered glass reflector. A 200-watt mazda, Type C, lamp is used.

The hammered glass reflector is spring suspended in a one-piece cast iron housing. The housing is closed by a wire glass front which is fitted into a recessed cast iron ring. This forms a door which is hinged at the bottom and secured by a hand latch, thus affording easy access to the interior of the housing. The recessing in the ring makes the interior of the housing fully weather-proof.

The lighting unit can be furnished in either a black or gray weather-proof enamel finish. It is 19¼ inches high and weighs approximately 30 pounds. This light weight makes the unit very easy to carry from place to place. The base is 9 inches in diameter, giving the light stability when mounted on a flat horizontal surface. The unit can also be mounted on either vertical or flat surfaces such as walls, poles or roofs, by virtue of a heavy universal joint which fastens the housing to the base. All adjustments can be made by hand—no tools are necessary.

The utility light has a wide range of applications. In railroad work it can be used for lighting transfer tables, coaling stations, inspecting pits, loading platforms, cranes, roundhouses and drawbridges. On marine work it can be used for lighting docks, dredges, slips, loading operations, canal locks, dry docks and pile drivers. Its industrial applications cover even a wider variety of uses such as lighting shop yards, material yards, coal yards, well drilling, coal tipples, erecting shops, machine shops, tramways and inclines, conveyors and all kinds of emergency work.

Trays for Elevating Platform Industrial Trucks

The Lyon Metallic Manufacturing Company, Aurora, Ill., has developed a type of side frame to be used in making up trays or platforms for elevating platform industrial trucks known as the Lyon Steel Skid Leg.

The skid leg consists of two welded feet which are, in turn, welded to a steel channel. This channel is

A Loaded Platform Ready To Be Removed By Industrial Truck

provided with bolt holes which are spaced so as to make it convenient to bolt on either a wood or steel top. The legs have rounded corners and a wide bearing surface for preventing damage to floors and resisting lateral thrust.

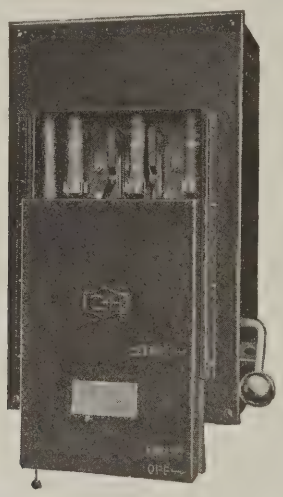
Additional supplies of platforms may be carried in stock, knocked down, so that they take up little space and yet may be quickly assembled. The wooden cross pieces can be drilled to fit the skid legs which are punched to a standard pattern. All that is necessary

to have a new platform complete and ready for use, is to get out the required number of cross pieces and bolt them to the skid legs. The platforms may be made any width, as width depends only on the length of the cross pieces.

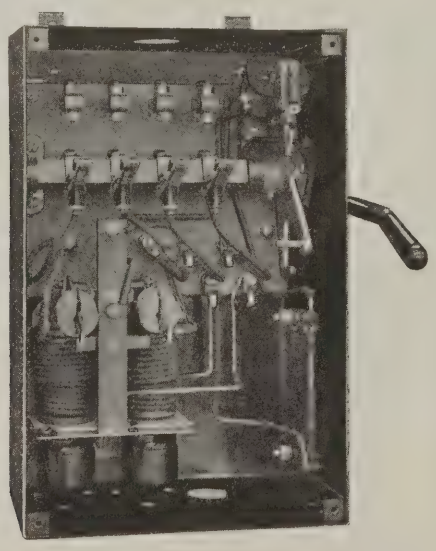
Enclosed Starters for Squirrel Cage Motors

Protection for both the motor and the operator is the principal feature of design in two new enclosed starting switches manufactured by the Cutler-Hammer Mfg. Co., Milwaukee, Wis.

One switch contains an overload protection unit, which is so designed that the circuit is not interrupted by a high initial starting current or by momentary overloads, yet gives protection against the continuance of harmful overloads. This inverse time element action is obtained by the retardation of a plunger in an oil dashpot. The time required for the relay to operate on any given overload condition may be varied by turning an adjusting screw.



Lowering of Panel of 3-pole Starting Switch deadens the fuses and makes them Accessible for Renewal



Switch with overload protection. The cover is removed showing contactors, duplex relay and low voltage coil

The other switch is a three-pole fused starting switch, especially adapted for those motors which cannot be connected directly across the line when starting. A resistor with two sets of terminals allows the motor to be started on either 60 per cent or 75 per cent line voltage. When the motor has reached normal speed, the resistor is cut out of the circuit and the fuses inserted, which is accomplished without breaking the motor circuit. Therefore, the fuses do not carry the heavy starting current, and need be of no greater capacity than to insure proper motor protection.

Both types of starters are completely enclosed and are so designed that it is impossible to touch any live parts either while operating or while renewing fuses and making adjustments. The enclosing cases, which are arranged for conduit wiring, prevent the accumulation of dust and grease on the contacts besides protecting the workmen from live parts. All contact posts and fingers are of standard *C-H* drum construction, easily inspected and renewed. Both types of switches are provided with low voltage protection coils.

To operate either type of starter, it is only necessary to raise and lower the handle, which can be locked to prevent unauthorized operation. The starters are made in various capacities for operating squirrel cage motors on potentials not exceeding 550 volts.

The Ralco Interlocked Safety Receptacle

The interlocked safety receptacle belongs to the line of Ralco devices handled by the Central Electric Company, Chicago. This particular device was designed to meet the ideas of electrical men and operating officials in order to obtain the desired safety features on outlets for alternating current welding circuits from 250 to 600 volts, 60 amperes.

This switch and plug device is so interlocked that the switch cannot be closed until the plug is pushed home to the correct position. The plug cannot be withdrawn until the switch is opened to the full "off" position. When the plug is withdrawn it automatically locks the switch open. The door cannot be opened until the switch is in the full "off" position. If anyone, when testing, should leave the switch closed it is not possible to insert the plug or bring the plug into contact with any live parts, until the switch is first opened. The plug and receptacle have four contacts; one contact is grounded. The receptacle ground contact is permanently grounded through the box to the conduit, in the usual manner. The plug ground contact makes contact to the ground contacts of the receptacle, before the live contacts of the receptacle are engaged. The plug handle is threaded for 1¼-in. Sprague Hose Armor which is grounded through the plug ground contacts. The box can be locked or sealed. The switch can be locked or sealed.

General News Section

The Van Dorn Electric Tool Company, Cleveland, Ohio, announces the addition of a new four-story building to its manufacturing facilities, making about 30,000 additional feet of floor space.

Electrification in Brazil.—The London Times Trade Supplement states that the electrification of the Barra to Pirahy Railway is likely to be carried out shortly as a government commission has recommended the system to be employed. The power will be obtained from one of the existing power companies. The cost of rolling stock, sub-station plant and transmission line will be nearly £1,000,000.

Fairbanks, Morse & Co., of Chicago, announces that this company will commence construction in the spring on a large modern foundry at Beloit, Wis. The new structure will be 900 ft. long, 550 ft. wide and will contain 495,000 sq. ft. of floor space. The plant includes the handling of material by modern electric machinery of all kinds. The working conditions and conveniences of employes have been given unusual consideration. A complete ventilation system will be installed that will change the air frequently. Other conveniences will include hot and cold shower baths for the entire force and a modern cafeteria where the men can secure hot meals. About 3,000 men will be employed.

The State of Pennsylvania is to have cautionary signals at all highway crossings which are not already protected, the Public Service Commission having arranged with the railroad companies of the state to furnish these signals. The total cost will be something like $200,000. The setting and care of these signals, which will devolve on the town, city or county authorities, seems to be a matter which is still the subject of negotiation, there being no compulsory law touching this feature of the matter. The Public Service Commission finds that there are in the state 11,738 highway grade crossings, of which 9,773 are unprotected.

In a Grade Crossing Accident at Clarksboro, N. J., on the night of November 1, about 11:20, sixteen persons were killed and about twenty injured, an automobile truck, occupied by thirty men and four women, on a pleasure trip, being struck by train No. 1926 of the West Jersey & Seashore, at a crossing which was without warning signals, but with approaches giving an unobstructed view. Clarksboro is on the Salem branch, 14 miles south of Camden. A coroner's jury on November 3 exonerated from blame the men in charge of this train. It appears from newspaper accounts that the pleasure-seekers were moving southward, and the passenger train northward, the crossing of the highway being at an acute angle with the railroad track; and there was a house near the crossing, except for which the headlight of the locomotive might have been seen sooner by the driver of the automobile.

Subscribers to the Bulletin of International Congress, have received from Brussels a rare souvenir; copies of the Bulletin for September and October, 1914. This bulletin, it appears from a slip attached to it, "was printed at the moment when Brussels was occupied (by the invaders) in August, 1914." The contents of this number consists mainly of reports presented for discussion at the Ninth session of the Congress; but it contains also the usual elaborate indexes of the volume for that year—January-October, 1914.

Effect of Railway Electrification on Telegraph and Telephone Lines

In a recent contribution to the Annales des Postes Telegraphes et Telephones, Prof. A. Mauduit stated, in recommending the electrification of French railways, that it would be necessary to remove telegraph and telephone lines to a distance from the electrified track, or, according to circumstances, to use bifilar, lead-sheathed, overhead or underground cables. This is the solution adopted in Switzerland and Italy, but it is not always practicable to remove the lines far from the railway, and, as pointed out by M. G. Valensi in a later contribution to the Annales, experience in the United States indicates that the conversion of lines to bifilar cables and their mechanical displacement from the electrified track are not sufficient to prevent interference. On the contrary, it is essential to take all steps possible to restrict the magnetic field of the traction system, e. g., by the use of counter-current wire, double-bridge distribution with compensating auto-transformers, and so on. Even these precautions, whilst securing satisfactory results under normal conditions in the traction system, can hardly prevent troublesome manifestations of electromagnetic induction in telegraph and telephone stations and in the homes of telephone subscribers under abnormal conditions, and, in particular, when short circuits occur on the traction system.—*The Electrical Review (London)*

PERSONALS

A. Clark Moore has resigned from the vice-presidency of the Safety Car Heating & Lighting Company to become associated with the Globe Seamless Tubes Company.

Benjamin Y. Payne, formerly car lighting electrician with the Pullman Company, with headquarters at Detroit, Mich., has become car lighting electrician on the Michigan Central, his headquarters remaining at Detroit.

Clarence J. Cowan, electrician first class, on the St. Louis-San Francisco & Texas railroad, at Memphis, Tenn., and Robert L. Sullens, electrician first class, at St. Louis, Mo., have been transferred to Fort Worth, Texas.

Morton Taylor, chief clerk of the Pullman Car Lines with office at Chicago, has been appointed assistant to the chief electrician of that road at Chicago. George H. Scott, electrical supervisor of the same road at Washington, D. C., has been appointed assistant chief electrician, also with headquarters at Chicago.

R. C. Horn, headlight electrician on the Chicago, Rock Island & Pacific with office at Herington, Kan., has been appointed terminal electrician with headquarters at Pratt, Kan., vice R. Aronson, F. C. Clifton succeeds Mr. Horn as headlight electrician.

Geo. F. Simmons, who recently was district manager for the Detroit and Cleveland offices of the Edison Storage Battery has resigned to enter the industrial truck field. Mr. Simmons was formerly associated with the old National Battery Company of Buffalo, N. Y., and the United States Light & Heat Corporation. In entering the industrial truck field he will become associated with C. E. Ogden, who represents the Automatic Transportation Company of Buffalo, N. Y., in Southern Ohio, and Indiana, West Virginia and Kentucky.

Harry M. Giles has been appointed general superintendent of the South Philadelphia works of the Westinghouse Electric & Manufacturing Company. Mr. Giles, who succeeds the late Oscar Otto, has risen from the ranks in the Westinghouse organization. For a number of years past he has been superintendent of marine erection, a position to which he was appointed by H. T. Herr when the electric company absorbed the machine company.

Mr. Giles was born in Boothbay, Maine, March 23, 1869, and when a small boy his parents moved to Providence, R. I., where he received his schooling. Leaving high school he went to work at an early age in the shops of the Corliss Steam Engine Company, where his father, Charles E. Giles, a well-known mechanical engineer, has been shop superintendent for the past thirty-five years. While working he took a night course in the Rhode Island School of Design and later received private instruction in mechanics, kinematics and mathematics. His close application to work in the Corliss shops won him rapid promotion as a draughtsman, but he irked to get into the actual work of machine construction. He accordingly apprenticed himself in the mechanical department. Upon the expiration of his apprenticeship he began to forge ahead in machine construction until in 1900 he became superintendent of Corliss engines with the Westinghouse Machine Company, a position he held until the company became a part of the present organization.

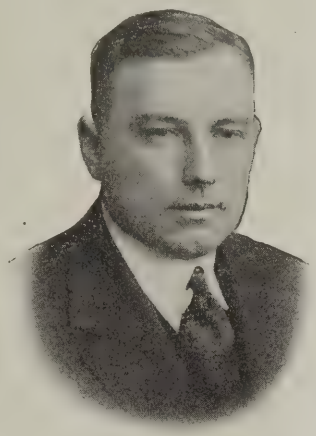
Louis J. Schneider has been appointed general sales manager of the Clark Tructractor Company, Chicago. Mr. Schneider is a graduate of the Stevens Institute of Technology, Hoboken, N. J., and is a member of the Society of Mechanical Engineers. He has been closely identified for many years with the Automotive industry, having served in the Engineering department of the Hyatt Roller Bearing company during 1911, and in the sales department from 1912 to 1916; during the early part of 1917 he was sales manager of the Jackson Rim Company, Jackson, Mich., and later in the same year he became sales manager of the Harrison Radiator Company, Lockport, N. Y., which position he resigned from to take charge of the sales department of the Clark Tructractor Company.

L. J. Schneider

Paul M. Lincoln, for many years commercial engineer with the Westinghouse Electric & Manufacturing Company, has resigned from that organization to enter the consulting engineering field. Mr. Lincoln is an international figure in electrical engineering. It was he who designed and installed the first hydro-electric plant at Niagara Falls and subsequently directed its operations for a period of six years. He was a pioneer in the high-voltage transmission line field and is today considered an authority on this subject. Among other notable inventions he perfected the Lincoln synchronizer for paralleling large electric alternators for which he received various medals and awards. Mr. Lincoln was elected president of the American Institute of Electrical Engineers in 1914 and has served for years on the Board of Managers and upon the Transmission Committee of the Institute. In his new capacity Mr. Lincoln will take up for the Lincoln Manufacturing Company the problem of motor drive for machinery, involving the determination of the proper type, characteristics and sizes of motors best adapted for direct connection to the various sizes and types of machinery.

Paul M. Lincoln

J. M. SPANGLER, southwestern railroad sales engineer for the National Carbon Company, Inc., Cleveland, Ohio, with headquarters at St. Louis, Mo., has been appointed to the position of western manager of the railroad sales department with office at Cleveland. Mr. Spangler was born at Middleburg, Pa., on December 2, 1889. He was educated in the public schools at McConnellsburgh, Pa., graduating from high school in 1906 and from the electrical engineering of the Pennsylvania State College in 1911. He began railway work in the signal department of the New York Central Lines in the same year. From 1913 to 1915 he was connected with the Railroad Supply Company, Chicago, as field representative in the signal department. In 1915, Mr. Spangler was appointed southwestern railroad sales engineer of the National Carbon Company, Inc., which position he held until his recent promotion.



J. M. Spangler

CHARLES S. PFLASTERER, manager of the caustic soda primary battery department of the National Carbon Company, Inc., Cleveland, Ohio, with office in that city, has been appointed eastern manager of the railroad sales department with the same headquarters. Mr. Pflasterer was born in Allegheny, Pa., in 1875. After spending two years in the steel mills at Braddock, Pa., he became connected with the Union Switch & Signal Company, Swissvale, Pa., in 1891 as a laborer. In 1893, he entered the employ of the Johnson Railroad Signal Company, Chicago, and from 1894 to 1901 was connected successively with various signal companies, the Chicago & Eastern Illinois; Cleveland, Cincinnati, Chicago & St. Louis; the Chicago Elevated Railway and the Chicago Great Western. In 1901, he was appointed interlocking foreman on the Union Pacific at Omaha, Neb. From 1901 to 1908 he was successively signal foreman, general signal foreman, superintendent of construction, general signal inspector and assistant engineer. In 1909 he was appointed assistant signal engineer on the Oregon Short Line with headquarters at Ogden, Utah. In 1911, he became connected with the National Carbon Company, Inc., in charge of the caustic soda primary battery department, which position he held until his recent appointment.

C. S. Pflasterer

WILLIAM F. COORS, salesman with the General Electric Company, located at Butte, Mont., has resigned from that position to become electrical instructor and inspector of electrification on the Coast division of the Chicago, Milwaukee & St. Paul, with headquarters at Tacoma, Wash. J. A. WRIGHT, general foreman of that road at Deer Lodge, Mont., is appointed division master mechanic at Tacoma, Wash., vice G. E. CESSFORD, who has been transferred to Bellingham, Wash., and M. R. MOODY, formerly general inspector and electrical instructor at Deer Lodge, Mont., succeeds Mr. Wright as general foreman.

RUSSELL W. STOVEL, who recently returned from France, where, as lieutenant-colonel of engineers he served as chief of the Terminal Facilities division of the Army Transport Service, has been appointed consulting engineer of the Westinghouse, Church, Kerr & Co., and as a member of that organization will devote his entire time to the company's electrical and mechanical work. Mr. Stovel has had an unusually comprehensive experience in electrical and mechanical problems connected with central power station and steam railroad electrification work, including the fundamental economics involved, the design, construction, equipment and operation. He was graduated from McGill University in 1897 with the degree of electrical engineer and the following year entered the employ of the Westinghouse, Church, Kerr & Co.; he soon became an assistant engineer, then successively engineer-in-charge, and mechanical engineer of the company, and finally managing engineer. In 1914, Mr. Stovel left the Westinghouse, Church, Kerr & Co. to become managing engineer for Gibbs & Hill, consulting engineer, New York. For this company he had direct charge of the Paoli-Chestnut Hill electrifications of the Pennsylvania Railroad, the Elkhorn grade electrification of the Norfolk & Western Railway, and the electrification of the New York Connecting Railway. While in France, Mr. Stovel occupied the responsible position of chief of Terminal Facilities Division, in which capacity he had charge of all matters relating to the procurement, maintenance and operation of all terminal facilities under the jurisdiction of the

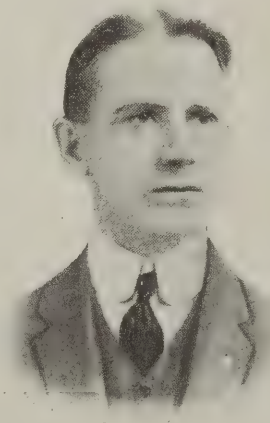
R. W. Stovel

American Transport Service. Mr. Stovel is a member of the American Institute of Electrical Engineers and of the American Society of the Mechanical Engineers.

SIDNEY WITHINGTON, who was made acting electrical engineer of the New York, New Haven & Hartford upon the resignation of P. J. KEARNS, was appointed electrical engineer of that road with headquarters at New Haven, Conn., effective November 1. Mr. Withington was born in Boston, Mass., June 7, 1884. He was educated at Harvard College, graduating in 1906. The following year Mr. Withington spent in completing his studies at the Lawrence Scientific School. He entered the service of the New York, New Haven & Hartford Railroad in January, 1910, and was associated with the design and construction of the electrification details of this road. He also assisted in a similar manner with the New York, Westchester & Boston Railway. Mr. Withington has practically been associated with electrification matters during his entire business career excepting for a short period in 1918, near the close of the war, when he served as First Lieutenant, Engineers.

Sidney Withington

J. C. McELREE, formerly assistant chief electrician with the Illinois Central, was appointed electrical engineer of Central of Georgia on November 1, with headquarters at Savannah, Ga. Mr. McElree was born in Republic county, Kansas, on May 5, 1878. He was educated in the public schools of Valparaiso, Ind. Mr. McElree's first experience in railroad work was with the Pullman Company, at Pullman, Ill. Later he worked for the South Side Elevated road in Chicago for about three years. Subsequently, he spent three years with various electrical contractors in Chicago. In 1904, he entered the service of the Illinois Central as an electrician at the Burnside shops. He was promoted to assistant foreman in 1908 and two years later was made foreman in charge. He was again promoted to assistant chief electrician in 1917, which position he held until his recent appointment with the Central of Georgia.



J. C. McElree

TRADE PUBLICATIONS

Electrical Instruments—Roller-Smith Company, New York. Bulletin No. 100 revised July, 1919, describes and illustrates direct and alternating current portable voltammeters and direct current portable ohmmeters for testing.

The Wellman-Seaver-Morgan Company, Cleveland, Ohio, has recently distributed bulletin No. 27, describing and illustrating the automatic ore unloaders manufactured by the company. The numerous photographs in the bulletin are taken from actual installations in various parts of the country.

Trumbull Cheer for November has arrived. This month's issue uses up considerable space telling us what we should be thankful for. It also points out the danger of harboring radicalism in the ranks of American labor.

Harvey Hubbell, Inc., Bridgeport, Conn., is distributing two direct mailing folders in which are illustrated and described the Hubbell lamp guard, with and without the locking feature, and the Hubbell reflector for use in various kinds of interior lighting.

Edison Primary Batteries.—Batteries for electric lighting of railroad signals are described in a handsome eight-page pamphlet issued by Thomas A. Edison, Inc., Bloomfield, N. J. The pamphlet contains also a handsome portrait of Mr. Edison and a brief sketch of the history of incandescent lamps since he made the first one on October 21, 1879.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., is distributing an illustrated booklet showing the various uses to which the C-H rectangular magnet, manufactured by this company, can be put. These rectangular lifting magnets are particularly adapted for efficient handling of regular shapes in steel and iron of this type of magnet in handling such kinds of material.

The Ohio Brass Company, Mansfield, Ohio, has recently issued its catalogue No. 205 which is devoted to the description and illustration of Imperial incandescent headlights for electric traction and mining service. The book contains 96 pages, its dimensions being 6 in. by 9 in. In describing the numerous types of headlight equipment the catalogue number is given, also the shipping weight as well as the list price of each unit. A number of wiring diagrams for use in connection with headlight installations are also given.

Electric Arc Cutting & Welding Co., Newark, N. J., has recently issued an illustrated booklet containing 22 pages in which is described the portable alternating current apparatus manufactured by this company. A number of photographs are included showing samples of the work done by the machine. A portion of the book is also devoted to the listing of auxiliary apparatus such as electrodes, electrode holders, face masks, etc. Three pages of illustrations showing the different types of welds that can be accomplished by this process are also included.

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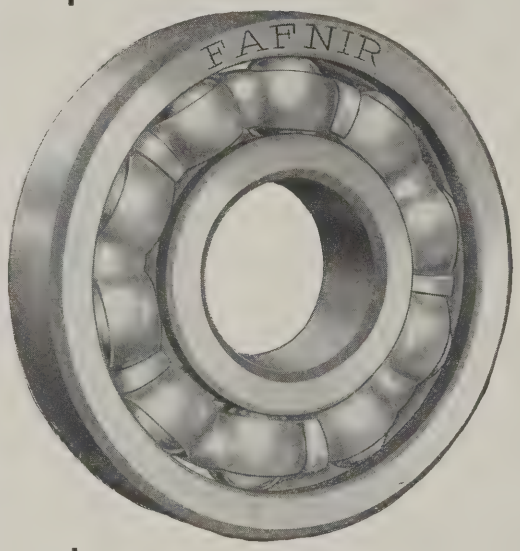

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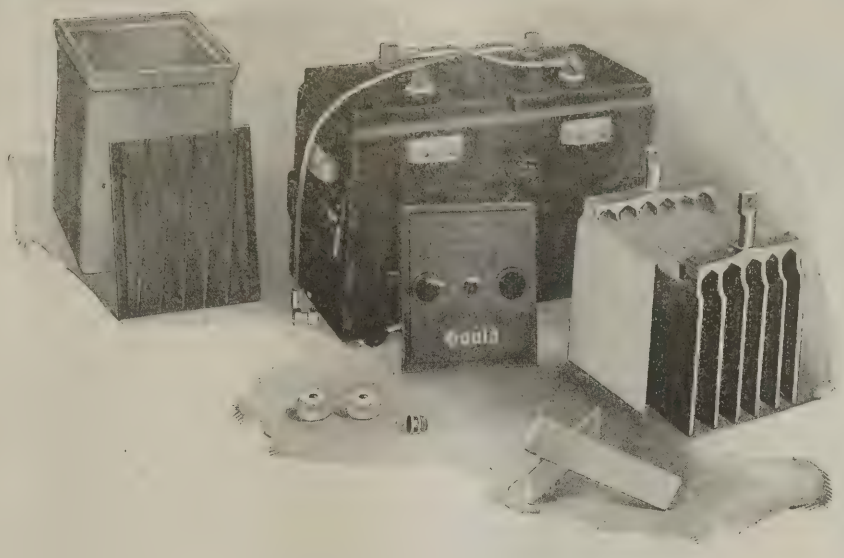
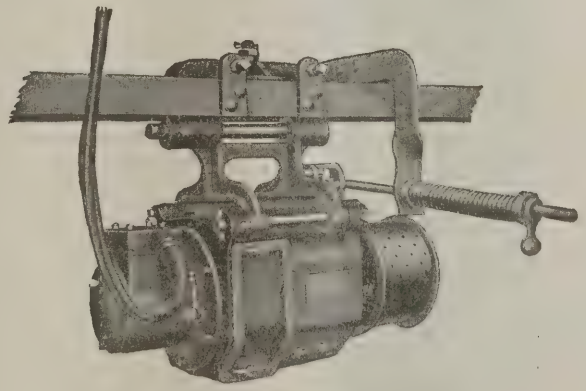


GOULD "SIMPLEX" SYSTEM



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91-16

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110 Volts..... 3 H.P.
220 Volts..... 5 H.P.
440-550 Volts..... 5 H.P.

High Torque Squirrel Cage Motors

110 Volts..... 4 H.P.
220 Volts.....7½ H.P.
440-550 Volts..... 15 H.P.

Enclosed Safety Starters Bulletins 91-16, 91-17 and 91-18 are the standardized starters for small and moderate size squirrel cage motors.

91-16 provides "start" and "run" and "off" positions by means of a handle operated from the exterior.

91-17

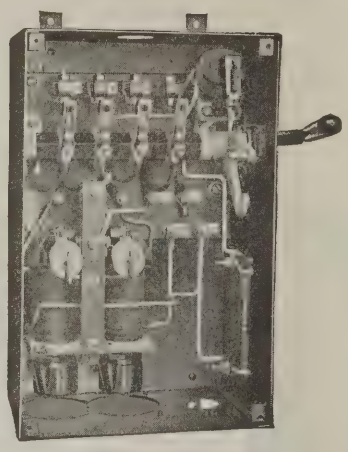
MAXIMUM CAPACITIES

Standard Squirrel Cage Motors

110 Volts..... 3 H.P.
220 Volts.....7½ H.P.
450-550 Volts..... 15 H.P.

High Torque "Internal Starting" Motors

110 Volts.....7½ H.P.
220 Volts..... 15 H.P.
440-550 Volts..... 25 H.P.



COVER REMOVED

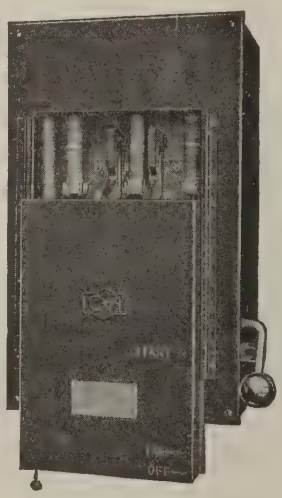
91-17 is a similar type of enclosed starter but with an inverse time element overload which while it allows momentary overloads, prevents sustained overloads.

91-18

MAXIMUM CAPACITIES

Standard Squirrel Cage Motors

110 Volts.....7½ H.P.
220 Volts..... 10 H.P.
440-550 Volts..... 10 H.P.



COVER LOWERED

91-18 is also like 91-16 but it is for use with standard squirrel cage motors in such locations where it is not desirable or permissible to throw the motors directly across the line. One step of resistance is inserted in each phase during the starting period. In the "run" position the resistance is cut out of circuit and the protective fuses are cut into the motor circuit.

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WE GUARANTEE, that of this issue 3,500 copies were printed; that of these 3,500 copies, 3,038 were mailed to regular paid subscribers, 58 were mailed to advertisers, 22 were mailed to employees and correspondents, and 382 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 36,195 an average of 3,016 copies a month.

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Volume 10 December, 1919 Number 12

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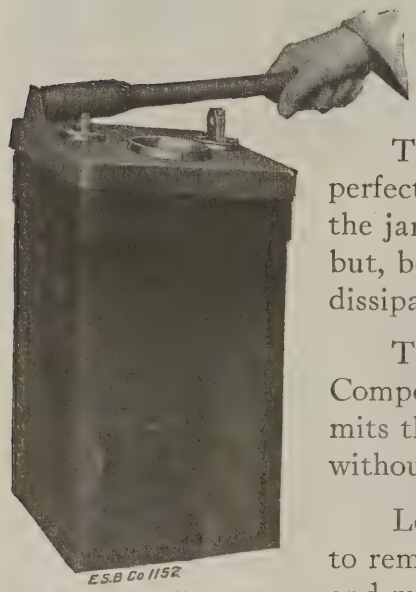

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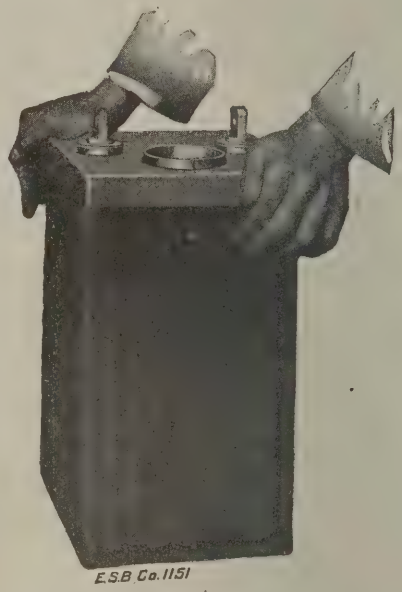

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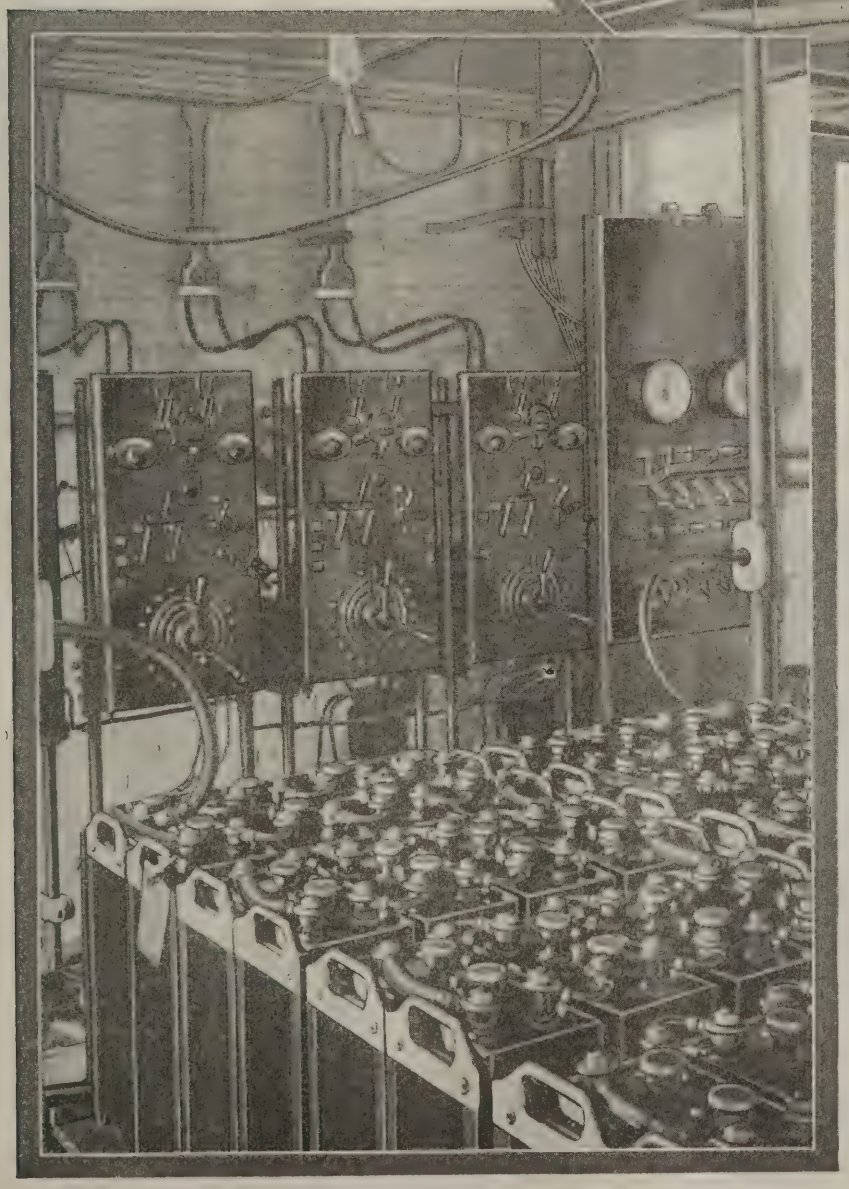
Batteries are made by this Company for every storage battery purpose

In the Signal Tower



With his eyes on the road, the man in the tower knows that

EDISON Storage Batteries FOR Railway Signaling

mean the greatest degree of safety to railroad traffic.

Edison Batteries are dependable in all emergencies.

They give the surest and most efficient battery service in all railroading.

Their entire freedom from noxious fumes enables them to be placed as close to the switchboard, relays, motor generators, or other apparatus as desired.

In this station, one of the most modern electric interlockings on a great system, two sets of Edison Batteries—100 cells in each set—were installed in 1913 and are still giving perfect satisfaction.

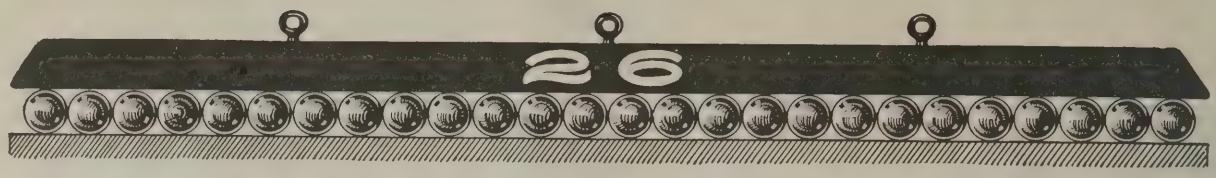
If you are interested in storage batteries for Railway Signaling, Bulletin 104 will interest you. (Bulletin 118 for Railway Train Lighting Batteries.)

Edison Storage Battery Co.

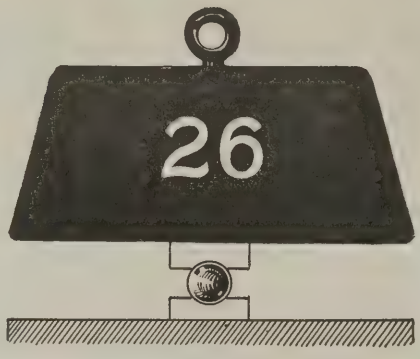
Factory & Main Office, Orange, N. J.

Distributors in

New York Boston Chicago Detroit
San Francisco Los Angeles Seattle
New Orleans Pittsburgh Kansas City
Scranton Philadelphia Denver
Syracuse New Haven Atlanta
Cleveland Washington



26 BALLS WILL CARRY MORE LOAD THAN 1



Rolling Between Plane Surfaces

In fact 26 balls will carry 26 times as much load as one working under the same conditions. But, if the curvature of the raceways is such that they very closely conform to the curvature of the ball, as in Gurney Ball Bearings,

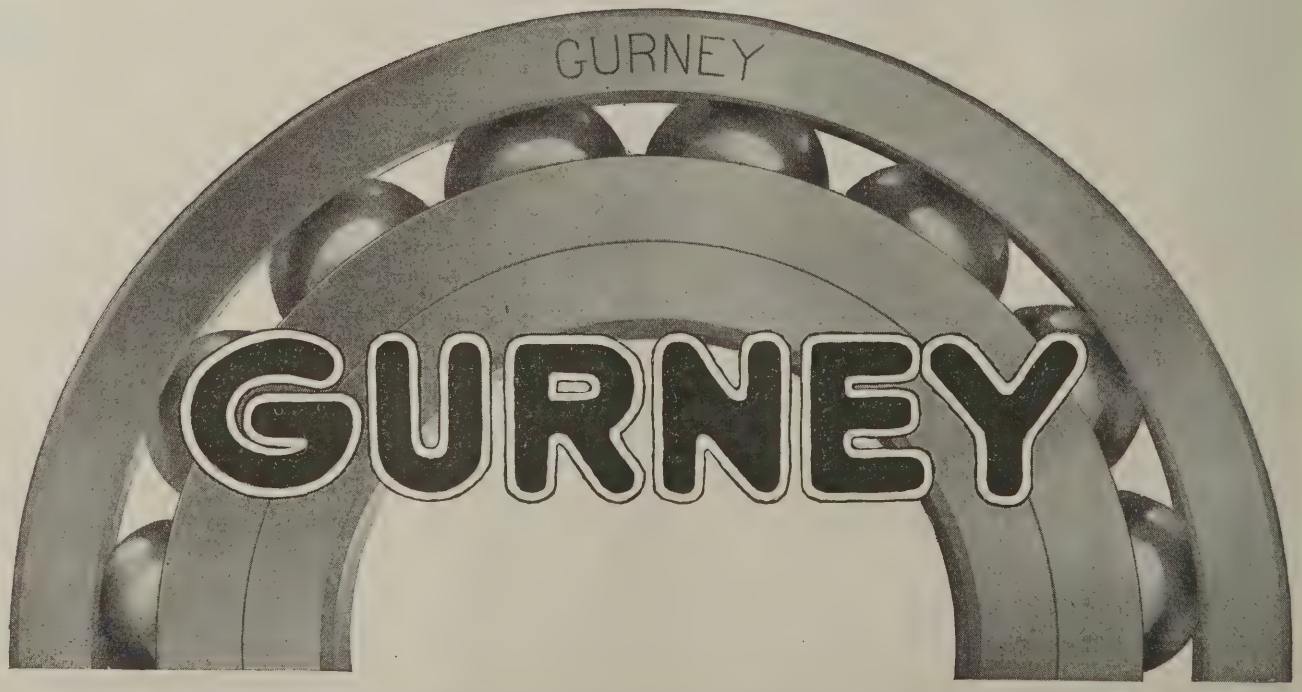
1 Ball Will Carry the Same Load as the 26 Illustrated

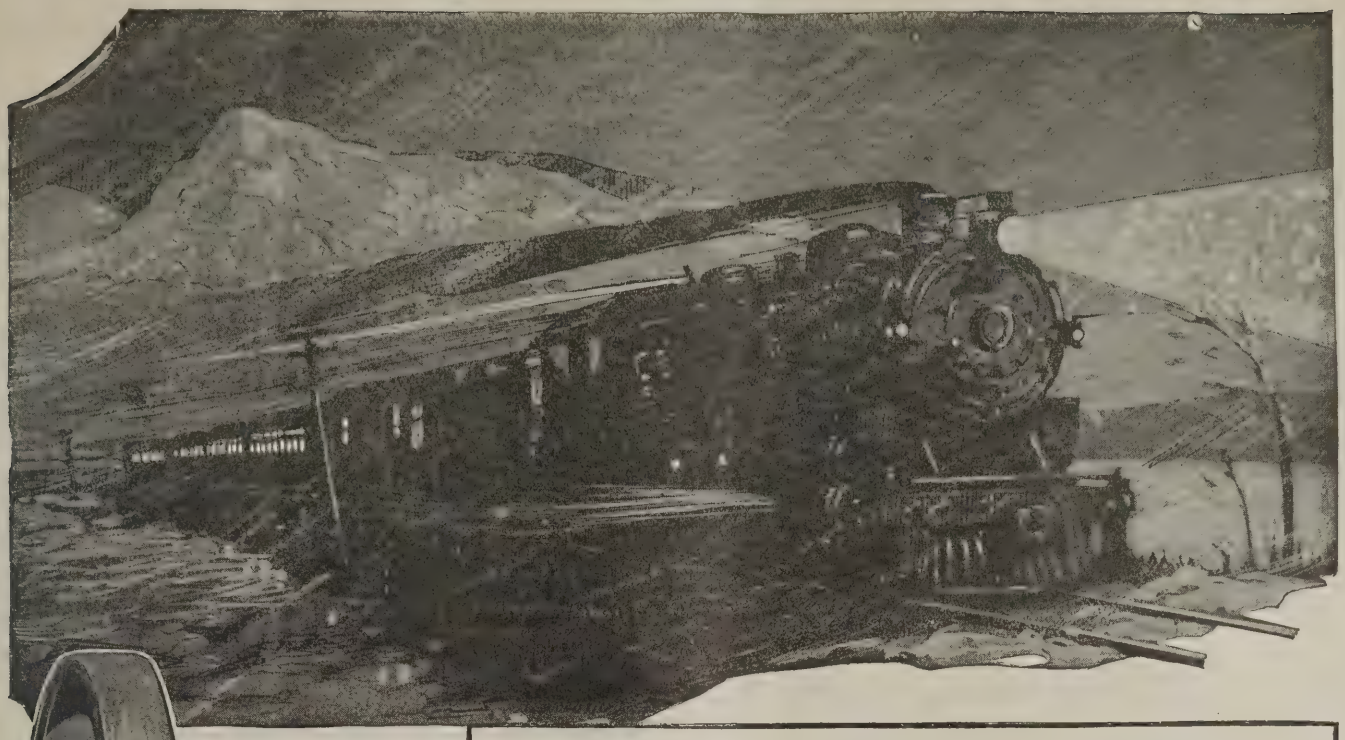
In Gurney Ball Bearings, not only is the maximum both in size and number of balls contained in a single row, but the contour of the raceways is such that a very close approximation to the curvature of the balls is realized. This utilizes, to the fullest possible extent, the capacity of each individual ball, because it brings into action the greatest possible amount of surface contact between balls and raceways under load. These facts account for the higher load capacity of Gurney Ball Bearings.

GURNEY BALL BEARING CO.

Conrad Patent Licensee

JAMESTOWN, NEW YORK





Judge SERVICE *by This* REPORT

The last report submitted by the Railway Committee on Data and Information showed that of axle lighting belts *exceeding* a belt mileage of 26,000 miles *all, but one, were Goodrich Axle Lighting Belts.*

With the finding before you, any other remarks would seem superfluous.

To say that Goodrich Axle Lighting Belt is adapted to any make of generator suffices. Its quality is *proven.*

THE B. F. GOODRICH RUBBER COMPANY
The City of Goodrich—AKRON, OHIO

GOODRICH

AXLE LIGHTING BELT

Western Electric
INSULATION

A FULL LINE OF INSULATION

Tapes—Splicing Compound, insulating and finishing varnish and all insulating materials are carried in large quantities at each of the Western Electric houses.

No matter in what part of the country you are located there is one of these near you. Our forty-two houses make it possible for us to render an exceptional

National Electrical Service for Railroads

Western Electric Amazon Tape is one of the leaders of our insulation line. It is a high quality tape, the basis of which is an unbleached sheeting selected for strength and durability, impregnated with a preservative and insulating compound which will successfully withstand severe atmospheric conditions and is so repellent to moisture that it is rainproof and snowproof. It is therefore exceedingly desirable for use where weather conditions are bad.

It is a good tape to use because—
It is thoroughly impregnated with two coats of insulating compound.
Has two spreader coats on top of insulating compound.
The surface is very evenly finished.
It is absolutely free from all pin holes.
Contains 80 ft. per ½ lb. roll exclusive of tin foil and carton. (An average of 30 ft. per pound more than other tapes.)
Has exceedingly high dielectrical strength.
Tensile strength of 35 lbs.
It is absolutely impervious to moisture.
Contains no chemical which would corrode copper or cause trouble.
It will not dry with age.
Is most economical—yardage considered.
Made to conform to most exacting specifications.

Write to us for a sample.

Splicing Compound

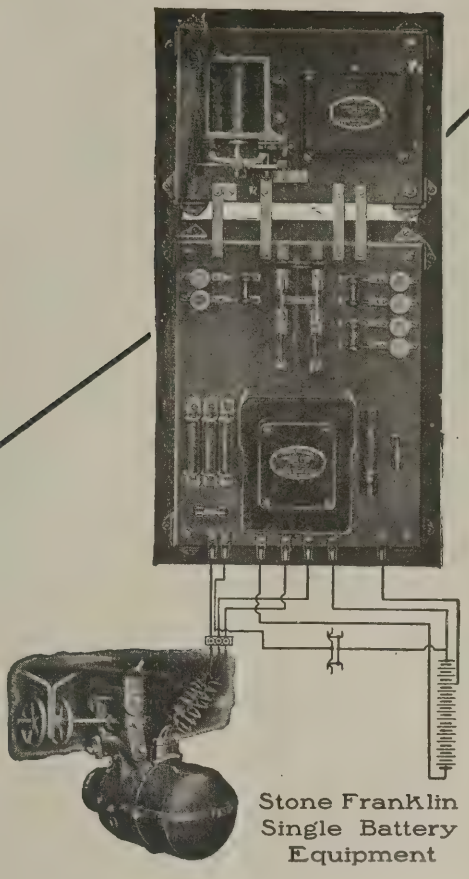
Amazon Splicing Compound is a high grade tape of rubber, providing a reliable joint-covering equal in insulation to rubber covered wire. Victor Splicing Compound is a good commercial product satisfactory for light and power work.

Insulating Varnish

Western Electric Ajax insulating varnish is a black moisture-proof varnish. It possesses the maximum amount of elasticity that is possible to secure in a quick air-drying varnish. Used for dipping armatures and field coils and also for repair work requiring a varnish which will dry without baking. We have a varnish that will meet your needs.

For detailed information consult our nearest house.

Western Electric Company
INCORPORATED
Offices in All Principal Cities



Stone Franklin Single Battery Equipment

Maximum Battery Life

Frequent flushing of batteries is the outward evidence of excessive overcharge and consequent rapid deterioration of batteries.

With Stone Franklin System the battery is at all times kept at maximum state of charge by efficiently effecting battery charging in minimum time and at such rates, varying automatically with the state of charge of battery that not only gassing, but also temperature of battery is kept at a minimum.

The watt controlled reducer switch, in co-operation with watt control of generator, automatically adjust the charging rates to the correct and most efficient values until the chief characteristics of the batteries indicate that charging has been completed, after which the generator is entirely disconnected from the battery, making battery protection definite and absolute.

This scientific method of battery charging efficiently meets the demands of the new car lighting era in which an equipment is operated without any adjustment, in both slow local service with frequent stops and fast main line service.

Stone Franklin Company

18 East 41st Street
New York

Transportation Bldg.
Montreal

KERITE

1919

1850

Judge insulating value not by price per foot, but by cost per annum

KERITE is *not* a speculation — it is an *investment*. The returns are assured by its performance record of half a century

KERITE INSULATED WIRE & CABLE COMPANY
NEW YORK CHICAGO

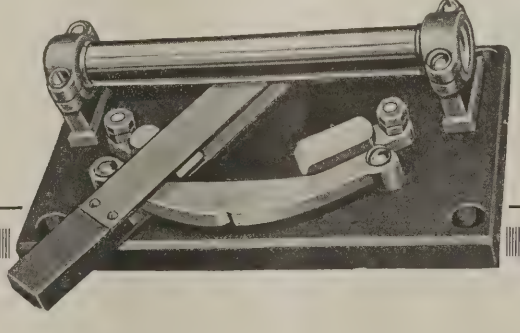
THE KEYSTONE
Locomotive Headlight Switch

They reduce the cost of switch maintenance to a minimum, far below that of other types of switches. They eliminate the worry, annoyance and confusion which always results from switch trouble.

They are constructed to give you good service for a long time. They are easy to operate. They provide the engineer with a switch which is strong; one which he can operate quickly and with satisfaction.

They may be easily repaired if broken. They are the only REAL locomotive headlight switches.

In construction they have many desirable features which make them the logical switch to use for locomotive service. Write for our Bulletin No. 145.



ELECTRIC SERVICE SUPPLIES CO.

Manufacturer of Railway Material and Electrical Supplies

PHILADELPHIA
17th and Cambria Sts.

NEW YORK
50 Church Street

CHICAGO
Monadnock Bldg.

HABIRLITE

LOCOMOTIVE HEADLIGHT WIRE

HABIRLITE is a specialized product adapted to its purpose by the unusual technical knowledge and experience of this organization. It is a reduced diameter insulation highly resistent to the deteriorating effects of heat, moisture and oil.

So successfully has Habirlite met the exacting demands of locomotive headlight work that it is now recognized as the ***standard*** headlight wire.

▼

HABIRSHAW

RAILWAY SIGNAL WIRE

This product, like every other Habirshaw wire represents the experience of a pioneer in the insulated wire industry and the highest modern engineering and manufacturing skill. Habirshaw has been known for reliability since the earliest days of electrical signal practice.

▼

RUBBER, PAPER and VARNISHED CAMBRIC CABLE
SECTOR and CONCENTRIC

MADE BY
Habirshaw Electric Cable Co., Inc.
10 East 43rd St., New York City

DISTRIBUTED BY
Western Electric Company, Inc.
Offices in all Principal Cities

A Big Task Made Easier-

During the four years past, the repair problem reached its maximum.
The need for serviceable rolling stock was then greater than ever before.
This practically enforced the adoption of speedier and more modern methods.

Electricity's Part

To those hard pressed, electricity alone afforded the greater speed and the greater dependability then needed.

Westinghouse Motors and Control

went into hundreds of shops—old and new—with beneficial results.

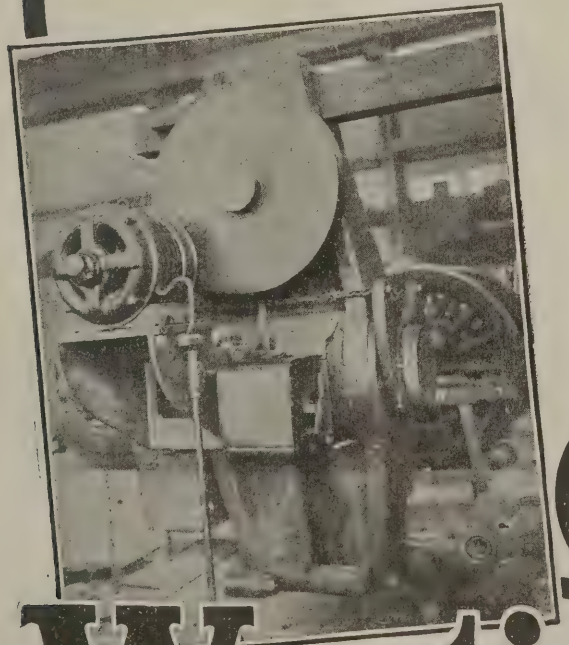
Lineshafting, hangers and belts that wasted power and swelled the cost of labor and upkeep, were displaced. More was accomplished with the same power consumption. The task of the machinist was simplified. Less time was consumed in the repair shop.

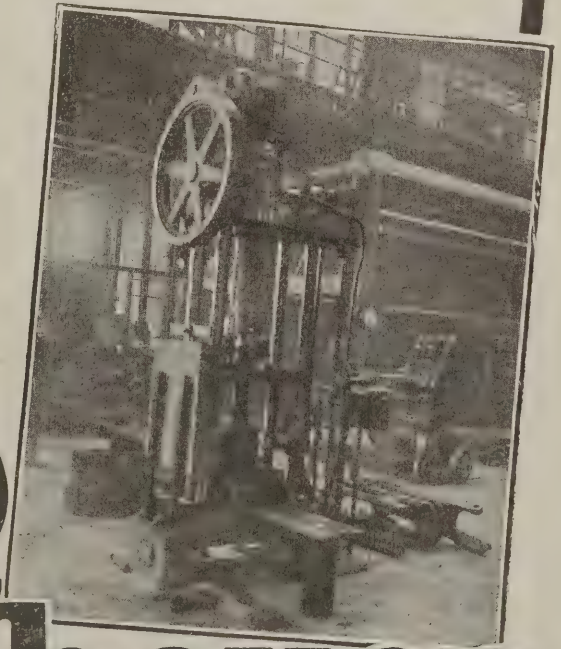
In no other industry has direct motor drive and automatic control proved more beneficial than in the railroad shop.

Electric drive means not only quicker repairs, but less unserviceable equipment in your yards.

Westinghouse Engineers will be glad to cooperate with you in the solution of your power problems.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.





W
WESTINGHOUSE ELECTRIC

Westinghouse

Dollar for Dollar

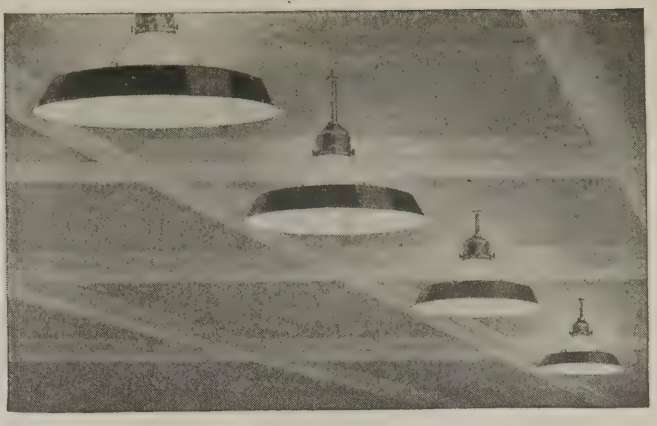
NEVER judge an advertising campaign from mere noise! The keen analyst, the shrewd business man goes behind the scenes. Extravagant use of space—clarion-like double page spreads don't always spell success unless they "deliver the goods." Get the facts and figures—study the check sheet. Then you will know just how much you are getting dollar for dollar.

As one national advertiser wrote: "Above all else, I believe the secret of the success which our trade paper advertising has met with is due to what one competitor has called 'extravagant' use of space. It is our experience that big trade journal space pays the largest dividends dollar for dollar."

Here are facts for the manufacturer who is prone to view his trade paper advertising indifferently.

Railway Electrical Engineer

Even the most efficient reflector can only cut out *part* of the glare if it must be seen against the deep black background of an unlighted ceiling.



The Glass-Top IVANHOE Reflector lights the ceiling just enough to avoid glaring contrast with the brilliantly lighted reflector below.

Another New "Ivanhoe"
A Glass-Top Reflector

THE new developments in lighting come from IVANHOE. Here is the latest—the regular RLM-type or bowl-type reflector made with a *glass top!* This permits a small portion of the light (10% or less) go to to the ceiling. By lighting the ceiling, you avoid the glaring contrast of a brilliantly lighted reflector against a black background.

The illustrations above show how glare is reduced—in fact, *for the first time completely eliminated*—by this new reflector! The glass-top steel reflector is an IVANHOE idea. If you still have a glare problem, why not order at once samples of this new reflector and *give it a tryout in a bay or a building?*

IVANHOE-REGENT WORKS of General Electric Co.
Cleveland, Ohio

"Ivanhoe" Steel Reflectors, Lighting Glassware, Anderson Self-Adjusting Arms and Illuminating Service

Ivanhoe Glass Top Reflector

The contour of the reflector is the same as before—the tried and proved RLM STANDARD type or bowl-type. It reflects the light efficiently into the working plane. It protects the eye from the intense brilliance of the MAZDA filaments. And now, by permitting a little upward flow of light to the ceiling, it protects the eye also from that other kind of glare—brilliant spots of light against the deep blackness of the ceiling! Both kinds of glare are bad. You've eliminated one—why not eliminate the other?

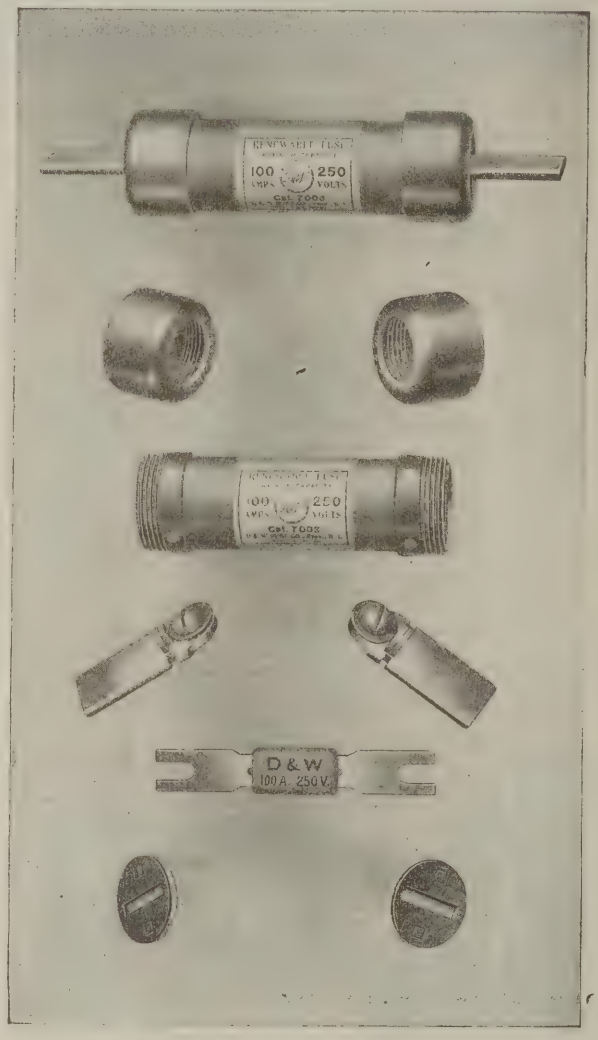
"Service to Lamps"

IVANHOE

SHADES-REFLECTORS

D & W RENEWABLE FUSES

Easy to Load—Always Aligned



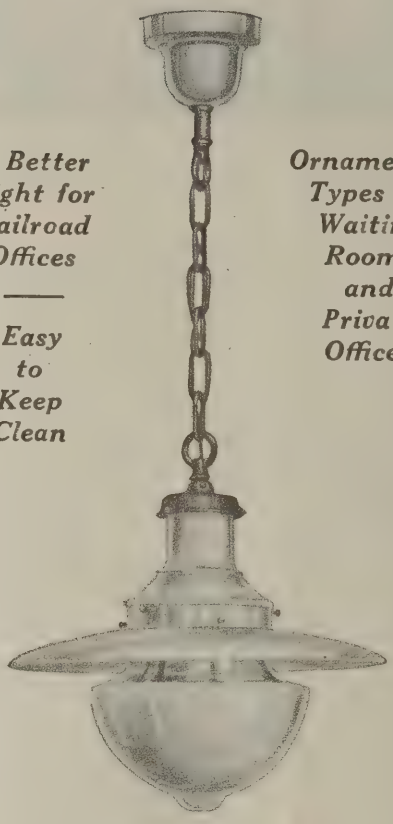
A rugged fuse is most essential in the renewable type, for unless a fuse casing is strong enough to be re-fused over and over again the whole object of a renewable fuse is defeated. This idea has been kept in mind in the design of D & W Renewable Fuses and every part has been provided with extra strength.

FOUR-IN-ONE Lighting Fixtures

A Better Light for Railroad Offices

Easy to Keep Clean

Ornamental Types for Waiting Rooms and Private Offices



PRACTICAL DESIGN

In construction, the Four-in-One is scientifically correct. It utilizes every ray of light from the highly efficient Mazda "C" or Gas-filled lamp. It is dust-proof and bug-proof, insuring maximum lighting power at all times.

Maintenance cost is low because dust can gather only on the exterior where it can be easily removed by a feather duster, from the floor, or with a dust cloth.

Central Electric Company

FOUNDED 1887

The House of Service

IT NEVER DISAPPOINTS

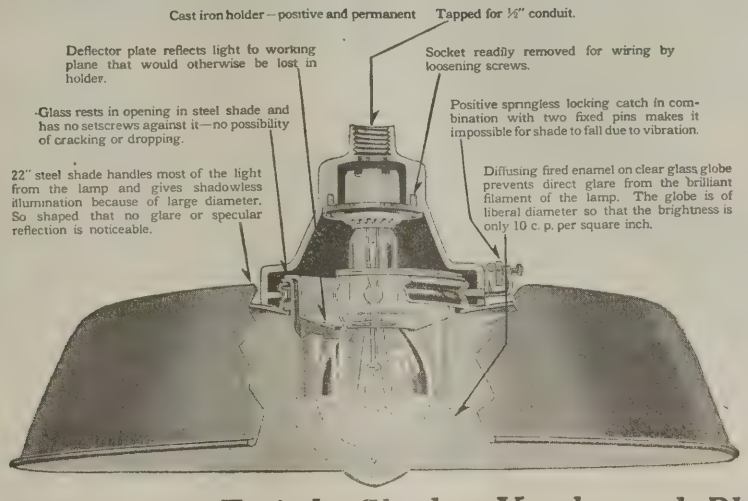
DISTRIBUTING JOBBER

316-326 South Wells Street

CHICAGO

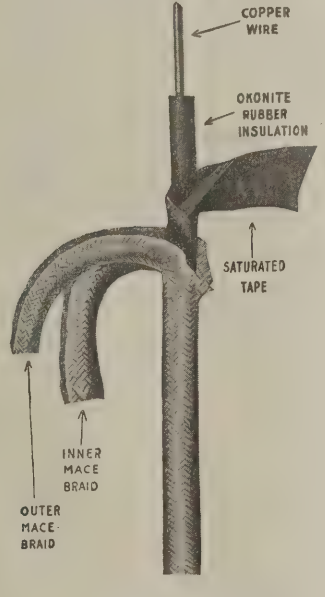
The Maxolite Diffuser

A Remarkable Development for Industrial Lighting


Cast iron holder—positive and permanent
Tapped for ½" conduit.
Deflector plate reflects light to working plane that would otherwise be lost in holder.
Socket readily removed for wiring by loosening screws.
No Shadow
Glass rests in opening in steel shade and has no setscrews against it—no possibility of cracking or dropping.
Positive springless locking catch in combination with two fixed pins makes it impossible for shade to fall due to vibration.
No Glare
22" steel shade handles most of the light from the lamp and gives shadowless illumination because of large diameter. So shaped that no glare or specular reflection is noticeable.
Diffusing fired enamel on clear glass globe prevents direct glare from the brilliant filament of the lamp. The globe is of liberal diameter so that the brightness is only 10 c. p. per square inch.
Dust Proof
Moisture Proof

For Roundhouses, Freight Sheds, Yards and Platforms

Okonite for Headlight Wiring

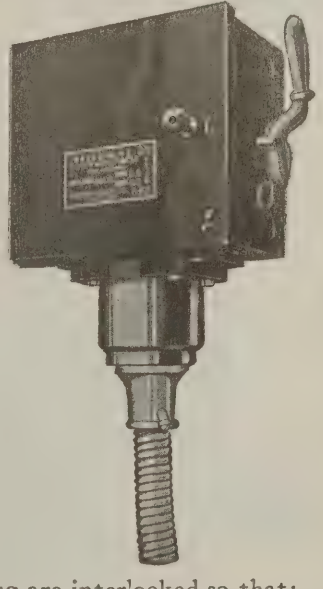


The requirements for wire for use on locomotives demands primarily an insulating compound of the best material available. This should be protected by heat resisting material.

The two destructive factors in locomotive wiring are moisture and excessive temperature changes. Okonite insulation provides protection against moisture and the special tape and two flame proof mace braids protect the insulation against excessive temperature changes.

Double Mace Braid Okonite wire is the ideal wire for locomotive wiring.

Ralco Safety Receptacles and Plugs for Welding



This line of INTERLOCKED Receptacles and Plugs was designed to meet the ideas of electrical men and operating officials who desire the maximum safety on portable outlets, on three phase circuits over 250 volts.

It consists of approved 60 ampere Safety Switch and a Ralco No. 42 Receptacle and Plug.

The switch and plug are interlocked so that:

Switch cannot be closed until plug is pushed home—

Plug cannot be withdrawn until switch is pulled to full "off" position, and other similar safety combinations.

Central Electric Company

FOUNDED 1887

The House of Service

OKONITE IT NEVER DISAPPOINTS

DISTRIBUTING JOBBER

316-326 South Wells Street

CHICAGO

Guaranteed by Fairbanks-Morse Quality

STURDINESS

—in construction is one of the principal characteristics of the Fairbanks-Morse Ball-Bearing Motor. This rugged construction is combined with the best points of electric motor design.

Take the solid one-piece frame. Its great strength and rigidity enables it to maintain alignment under the heaviest gear, chain or belt pressure. The feet—broad and substantial, are cast as part of the frame.

FAIRBANKS-MORSE
BALL-BEARING MOTORS

The Rotor Winding is one piece of solid metal, with bar ends cast on and end rings melted in—another feature of sturdy construction.

Ball-Bearings packed in grease reduce friction, save current.

Fairbanks, Morse & Co.
MANUFACTURERS CHICAGO

Engines - Pumps - Motors - Hoists - Air Compressors - Fairbanks Scales - Sheffield Motor Cars - Standpipes - Coaling Stations - Etc.

"Come up on the running board I want to show you something"

"DID you ever carefully examine this little G-E Turbo-Generator. Well, it is worth your while. You don't know what a real piece of mechanism it is, unless you have had the pleasure of taking care of one.

"Why, the only time I ever look at it is to admire it or oil it about once every two weeks.

"It never is out of order and judging from its appearance and its smooth operation will last as long as I do."

Such is the opinion of one engineer and it is indicative of the opinion of many engineers having to care for one of these little perfections in turbine design, the

G-E Turbo-Generator for Headlights

Four years of exhaustive test — a knowledge accumulated from a vast amount of experience in turbine manufacture — have resulted in the building of this highly efficient, simple yet unusually strong device.

Electrical Advantages

The magnetic speed control used only in the G-E headlight set affords the following advantages:

Impossible to burn out armature and field coils from overload or short circuit.

A constant voltage is maintained, thereby insuring maximum life of lamps.

A minimum of inspection and adjustment required.

Machine is fool-proof.

Mechanical Advantages

Elimination of wear of the bucket wheel due to the drying of the steam by steam separator.

Screen prevents foreign matter from entering reducing valve.

Reducing valve of simple design. No delicate parts to get out of order.

Turbine wheel is of the Curtis type, and represents the same care and design as that used in all our turbine manufacture.

Heavy shaft. Complete rotor carefully balanced at factory.

Brush holders of rugged design.

Brushes readily accessible.

Ball bearings of standard manufacture, located on ends of shaft and readily accessible.

Either oil or grease lubrication. No grease cups required.

Brushes and bearings only parts subject to wear.

Drop a line to our nearest office and get Bulletin 42014A, which gives complete information.

28-24

General Electric Company

General Office Schenectady, N.Y.

Removing the Brake

FRICTION is the relentless enemy of efficient operation. In the average mill it destroys at least 25 per cent of all the power produced or bought.

Yet this tremendous waste can be largely reduced—in fact, has been reduced to a minimum in hundreds of plants of every description through the aid of S K F Bearing Engineers.

These practical engineers, backed by the fund of knowledge constantly available in the S K F Research Laboratories, render an invaluable service. They remove the break that slows down production by solving perplexing and costly friction problems.

Manufacturers are invited to avail themselves of this bearing service at any time.

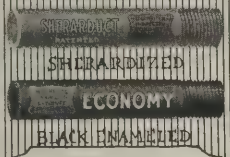
S K F INDUSTRIES, INCORPORATED
Sales, Service and Research Division
165 Broadway, New York City

570

SKF INDUSTRIES

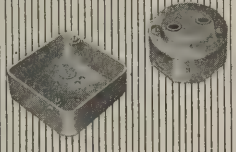
Hess-Bright Ball Bearings
S K F Ball Bearings
Atlas Steel Balls
Gronkvist Chucks
Transmission Hangers

NATIONAL PRODUCTS

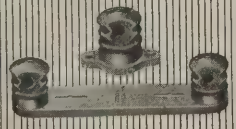


SHERARDUCT
The Rigid Steel Conduit with both surfaces Sherardized *and* Enameled.
ECONOMY Black Enameled Conduit. There's none better
Write for Bulletin 50

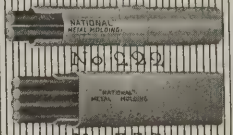
FLEXTUBE
Interwoven — Seamless — Non-Collapsible. Inseparable and Double Compounded. Easy to fish and every foot of every coil can be used
Write for Bulletin 151



"National"
Outlet Boxes and Covers
A box for every purpose and a purpose for every box. Furnished in Sherardized or Black Enameled Finish..
Write for Bulletin 250



"National"
BRACKETS
Complete with insulators. Sherardized Bases. Wires run straight through. No Tie-Wires necessary
Send for Bulletin 602



"National"
METAL MOLDINGS
For two, three and four wire surface wiring. Lowest installation cost of any metal wiring system.
Write for Bulletin 101

FLEXSTEEL
Distinctive flat surface. Easy to fish, cut and strip. Ideal for wiring either old or new buildings. A complete line of improved fittings
Write for Bulletin 201

"National"
Locknuts and Bushings
Threads sharp, clean and true. "National" quality products. Exclusive self-cleaning-feature in the bushings.
Write for Bulletin 350

"National"
FIXTURE STUDS
Sherardized Stamped Steel. Hollow Stems. Stronger, and yet lighter, than any other stud on the market.
Write for Bulletin 400

A Comparison

Sherardizing Steel & Creosoting Wood

The Purchasing Agent for one of the largest Hydro-Electric Power Companies, upon having the Sherardizing Process thoroughly explained to him, remarked:

> *"Then Sherardizing, as a method of protecting steel, is like creosoting for protecting wood."*

He has since insisted upon the delivery of **SHERARDUCT** on all conduit orders.

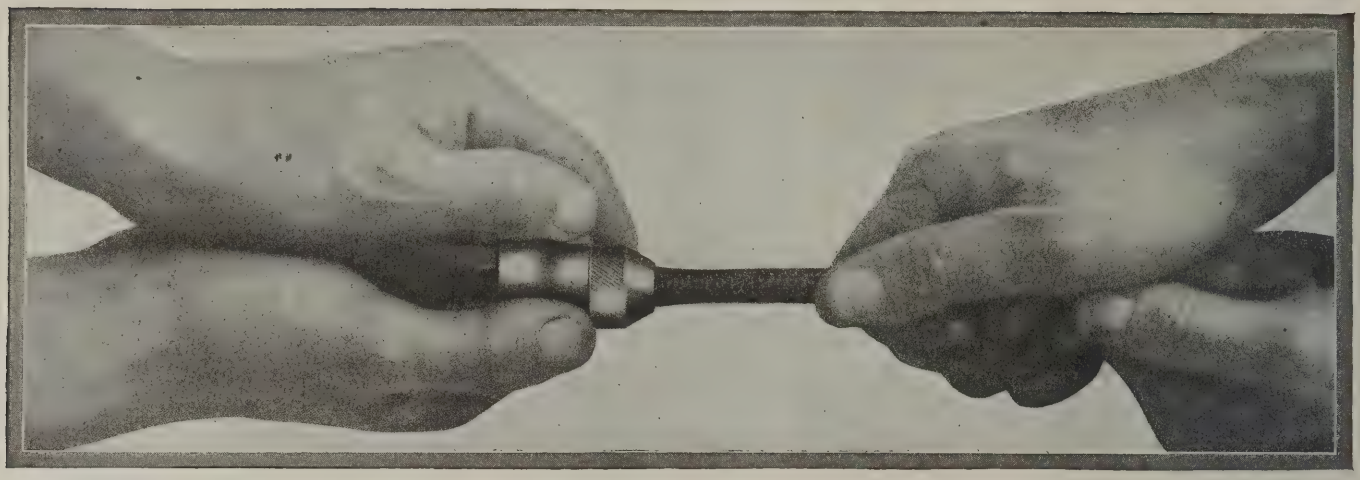
The two processes are markedly similar, both in treatment and results attained. **SHERARDUCT** is the only Sherardized Rigid Steel Conduit. Both interior and exterior surfaces are Sherardized and further protected by coatings of a clear acid- and alkali-proof enamel, baked on. Has the combined advantages of zinc and enamel protection. Double value for one price. We can't tell you all about it here; write for complete information.

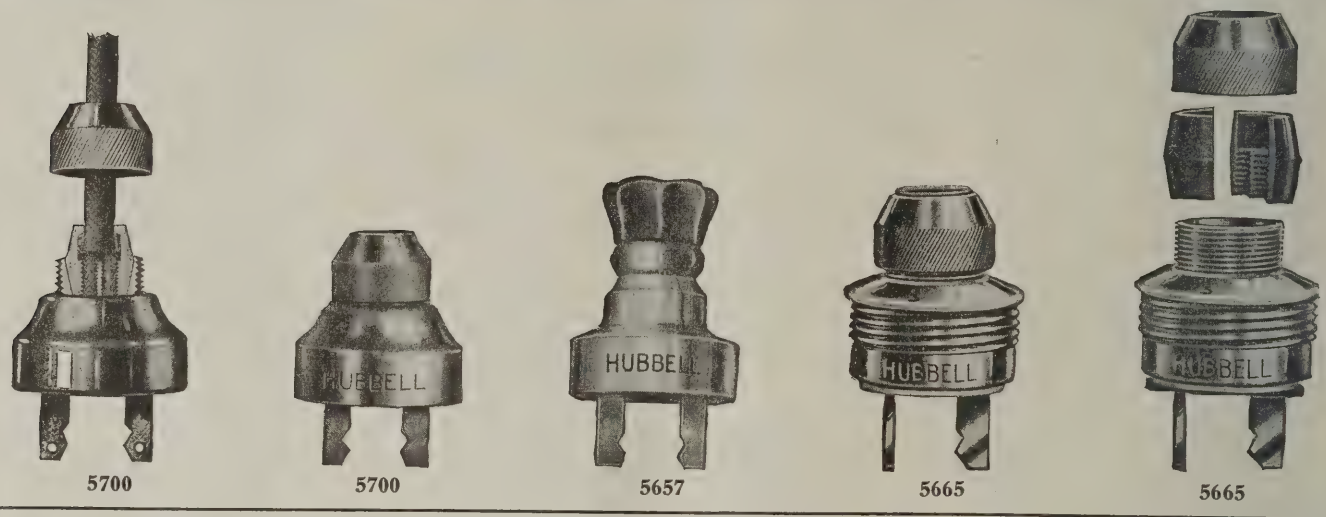
National Metal Molding Co

1122 Fulton Building
Pittsburgh, Pa.

Atlanta	Chicago	Havana	Paris	Salt Lake City
Boston	Dallas	Los Angeles	Philadelphia	San Francisco
Buenos Aires	Denver	Manilla	Portland	Seattle
Buffalo	Detroit	New York	Rio de Janeiro	St. Louis 119

Canadian Distributors—CANADIAN GENERAL ELECTRIC COMPANY, Limited





5700 5700 5657 5665 5665

"KNOSTRAIN" CAPS

We make a complete line of standard caps, plugs, receptacles, sockets, reflectors, lamp guards. Our catalog explains the line and gives prices. May we put a copy in your hands?

Sometimes a yank on the cord is quicker than withdrawing the cap with the fingers.

But the man who does the yanking isn't considering whether or not the cap will stand such handling.

He wants to get it out in a hurry.

So, with the ordinary cap, the wire is often dragged from the contact screws, the line is short circuited and work stopped until a new fuse can be put in.

But if you have equipped your plant with "Knostrain" caps, all the yanking in the world won't injure them. The bushings take up the strain, clamping down tight on the wires, and relieving the contact screws.

Your men save time, and you save the value of the time they save. Thus everybody's satisfied.

2021U

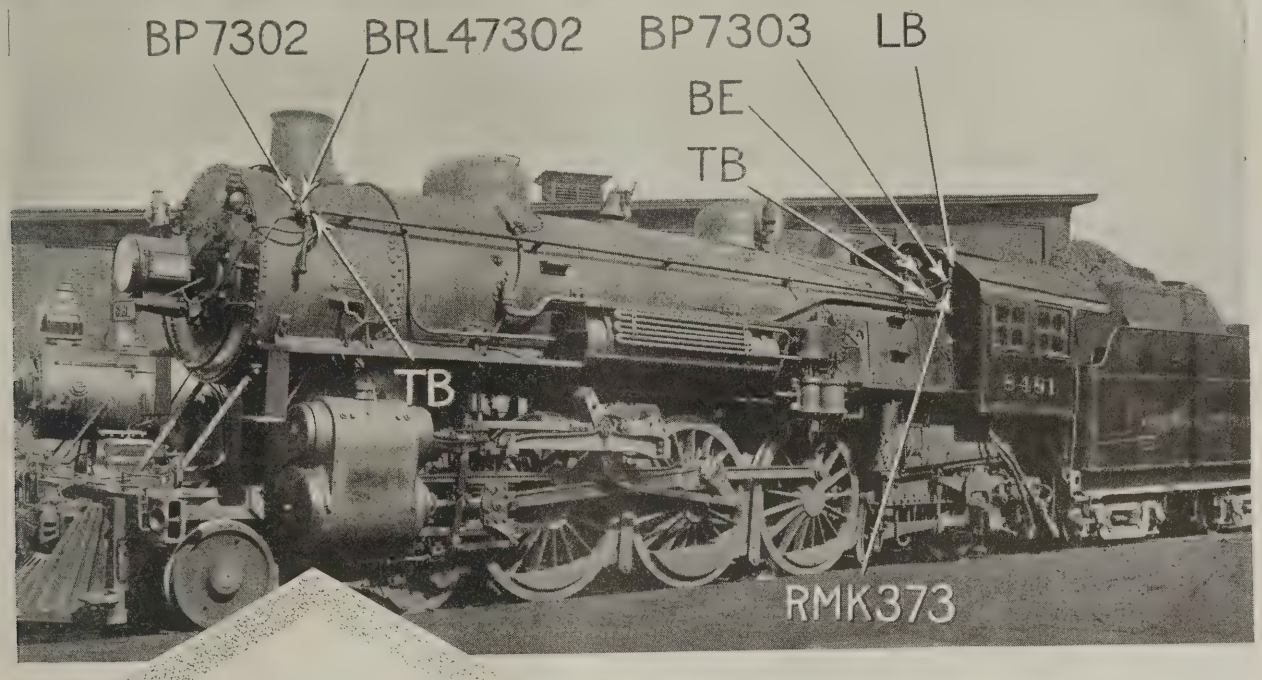
HARVEY HUBBELL INC

ELECTRICAL SPECIALTIES

BRIDGEPORT HUBBELL CONN. U.S.A.

REG. U. S. PAT. OFF.

CONDULETS



WIRING the Locomotive

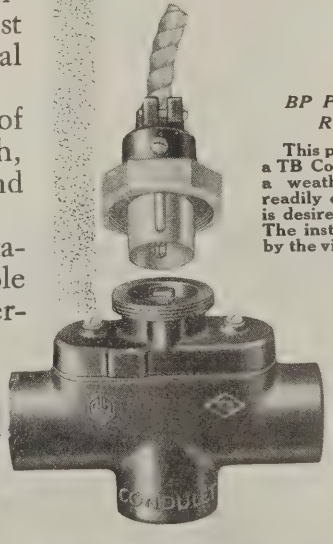
THE wiring on locomotives must be inclosed in conduit, for protection against the weather, destructive gases and mechanical injury.

There is a Condulet for every detail of locomotive wiring including headlight switch, hand rail connector, gauge lamp, plugs and receptacles and so forth.

Write now for the Crouse-Hinds Catalogs and Bulletins. They contain valuable information and suggestions. Our engineering department is at your service.

CROUSE-HINDS COMPANY
SYRACUSE, N. Y.

Panel Boards Knife Switches
Guy Anchors Condulets
Flood Lights



BP PLUG AND BRL RECEPTACLE

This plug and receptacle on a TB Condulet body furnishes a weather-proof connection readily disconnected when it is desired to remove a lamp. The installation is unaffected by the vibration of the engine.

Condulet the Job

CROUSE-HINDS

Make the Lamp Come Down for Cleaning

Do not require your men to climb on girders, cranes or ladders, for unless the lamps are easy and safe to get at, the cleaning is going to be neglected.

Thompson Safety Disconnecting Hangers

will safeguard the lamp cleaner and make the work easy—cut out all difficulties, and then you can more successfully insist on having the work done properly.

Unless the reflectors are kept clean and sparkling, the money paid for them is wasted.

Give a touch of reality to the supposed value of all your high lamps.

Write for our Booklet B-18

Looks TRIM IS SAFE

THE THOMPSON ELECTRIC CO.
5606 Euclid Ave., Cleveland, Ohio

A Reflector for Every Purpose

whether shop, station platform, trainshed, freight shed or yard

WHEELER "1300" REFLECTORS

light them all properly. Each of the six different types of reflectors diffuse the light correctly to meet the conditions for which they were designed.

The substantial galvanized cast canopy, resisting moisture and acid atmospheres, serves as a universal fitting and permits interchanging any of the six types, in all sizes to fit all Mazda "C" lamps from 25 to 1,000-watt sizes.

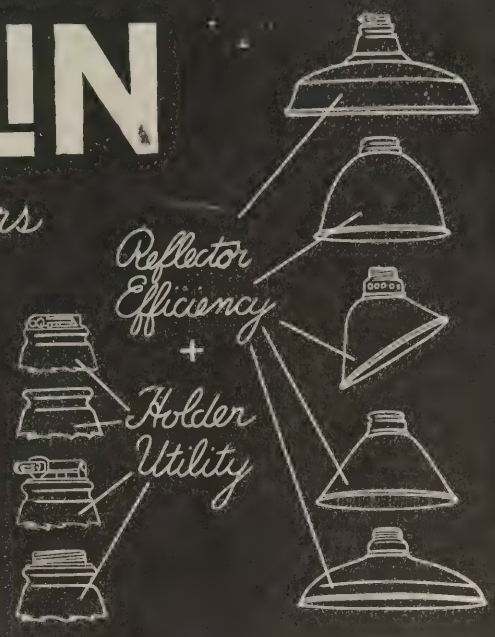
The Wheeler Reflectors are designed for interior and exterior installations, high yard, low platforms, high shop and low shop lights.

Write for our descriptive bulletin F. B.

WHEELER REFLECTOR CO.,
156 PEARL ST., BOSTON, MASS.

BENJAMIN

Shade Holder Reflectors Combine Efficiency and Utility



WHERE the heights and spacings of present light sources may be retained and circumstances make it inexpedient to disturb the existing wiring plan, adequate illumination is at times secured by the use of new lamps and reflectors.

Where it is desired to attach the new reflector to a socket already installed, Benjamin Shade Holder Reflectors will insure the correct position of the reflector on the socket with relation to the position of the lamp.

Benjamin "Built-In" Shade Holder Reflectors are a Union of Shade Holder and Reflector in One Piece

Type "B" Shade Holder Reflector is designed for attaching to any standard brass shell socket. This socket is the one commonly found in existing interior lighting installations.

Type "P" Shade Holder Reflector is equipped with a holder which will fit any standard porcelain socket.

Type "N" Shade Holder Reflector is fitted with a neck so shaped as to fit into any standard 2¼-in. shade holder.

Type "S" Shade Holder Reflector has a screw threaded holder designed to fit Benjamin screw threaded sockets and fittings.

Benjamin Shade Holder Reflectors include the

R-L-M Dome, Bowl, Angle, Focusing or Cone and Shallow Bowl types

The high efficiency of a modern, scientific reflector is made possible in old installations through the utility of the "built-in" shade holder.

Interesting literature regarding Industrial Lighting and the utility of Benjamin Shade Holder Reflectors will be sent on request

BENJAMIN ELECTRIC MFG. CO.

247 West 17th St.
NEW YORK

Sales and Distributing Offices:
806 West Washington Blvd.
CHICAGO

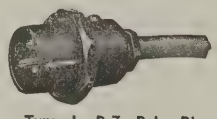
590 Howard Street
SAN FRANCISCO

BENJAMIN

Makers of Things More Useful

Locomotive Tender Signal Lamps and 2 and 3 Pole Plugs and Receptacle for Connecting Tender to Locomotive

Front View
Type L T L Signal Lamp



Type L P-3 Pole Plug

Type L P-3 Pole Plug

Type L R A-3 Pole Receptacle

Side View
Type L T L Signal Lamp

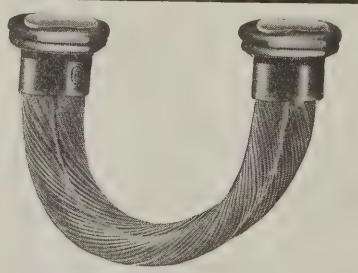
Type L R A Receptacle

Type L R B Receptacle

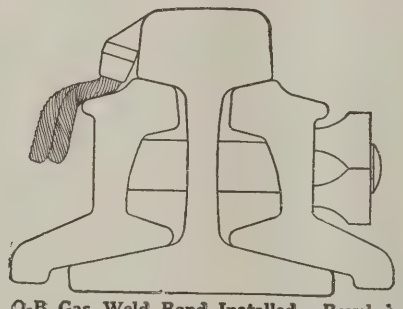
Type L P-2 Pole Plug

Write for Bulletins

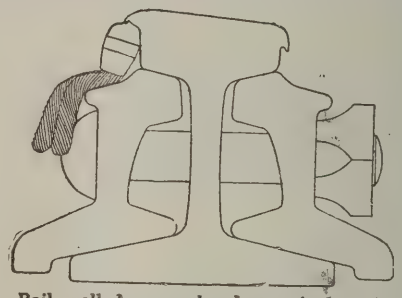
OLIVER ELECTRIC & MFG. CO., - - St. Louis, Mo.



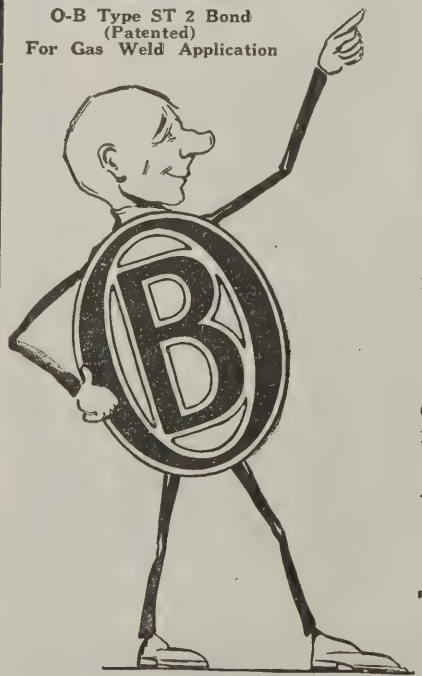
O-B Type ST 2 Bond
(Patented)
For Gas Weld Application



O-B Gas Weld Bond Installed. Beveled shape of finished terminal is patented.



Rail rolled over bond terminal uninjured. Drawing made from life.



Unusual Demonstration of O-B Bonds

One of the heaviest electrified steam roads had so much trouble with rail breakage that softer rail was installed. This soft rail distorts more rapidly but is safer.

A trial installation of O-B Gas Weld Bonds was made in the most severe section of the line—on up-grade curves.

The illustrations tell their own story. Some bonds were removed on account of rail replacements. Of the rest more than 90% are in perfect condition after 15 months of punishment.

O-B Gas Weld Bonds were the pioneers. Four years have proved that there is no injurious effect on the rails.

Send for Steam Road Electrifications.

The Ohio Brass Company, Mansfield, Ohio

Point of Contact

HAVE you ever tried to analyze your product as to its advertising possibilities? Have you ever gone deep down into its sales possibilities to find the "point of contact" between it and its possible buyers?

Often the "point of contact" is hard to find, for it is always the obvious that escapes us.

If a product or device makes for economy, savings, etc., obviously the point of contact is along these lines—but your message should be so placed before the maintenance of way man that your appeal comes within his experience.

Often an advertiser hesitates before he launches his campaign—he feels that he is unable to write a sales-message.

Our copy-service department may be able to assist you in establishing the correct point of contact.

Call upon us to assist you whenever you feel that your copy-plan needs the viewpoint of the man outside.

Railway Electrical Engineer

A reliable pulley for car lighting

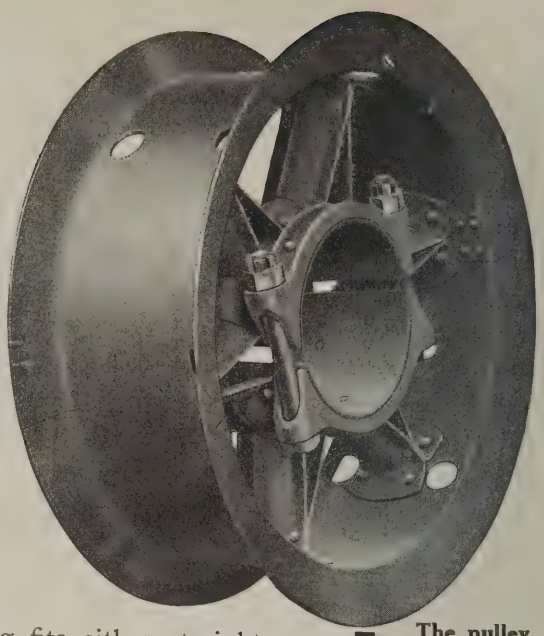
Car axle lighting pulleys must run in sand and mud in summer, in ice, slush and snow in winter. They must withstand jolts and jars of rough road beds at all seasons.

To give satisfactory service under these severe conditions requires an exceptionally strong pulley and a bushing that will positively prevent it from slipping on the axle.

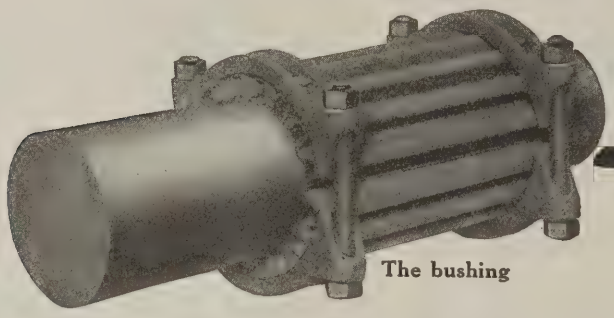
The Keystone car lighting pulley with Oneida corrugated bushing

The combination of Keystone steel pulley and Oneida corrugated steel bushing is standard with many of the best car builders in America.

The design of the pulley and the materials from which it is made insure maximum strength and endurance.



The pulley



The bushing

The bushing fits either straight or tapered axles. It grips the axle firmly under all conditions.

Write us for full information regarding this practical combination.

Dodge Sales and Engineering Co.,
Oneida, N. Y., U. S. A.
Distributor of the Products of Dodge Mfg. Co. and Dodge Steel Pulley Corporation
Originators of Steel Railroad Pulleys and Steel Corrugated Bushings

FOR seventy-one years Hazard Products have stood for reliable and dependable service.

Seventy-one years of "plugging" steadfastly through lean times and prosperous times, always with one purpose—to maintain and continually refine the high standard of quality that has always characterized Hazard Products.

Trade Mark

For dependable service in railroad station and shop lighting, passenger car, and signal wiring, and high tension power circuits use

1848-1919

HAZARD
RUBBER COVERED
WIRES & CABLES

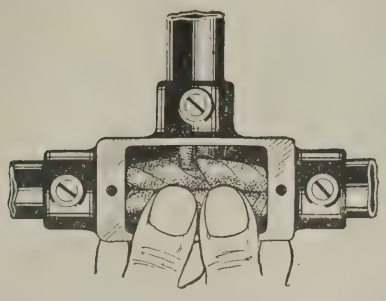
HAZARD MFG CO
WILKES-BARRE PA

NEW YORK 533 CANAL STREET
PITTSBURGH 1st NAT'L BANK
CHICAGO 552 W ADAMS ST

Makers of Quality Wire Rope since 1848

"PIPE TAPLETS"

"The Fittings with Hub Set Screws".



After the wireman has completed his splices in a fitting he knows that his job is only about half done if his boss is buying the ordinary pipe fitting. He still has to push the splices down into the fitting and this is usually accomplished by the use of a hammer or the butt end of a screw driver.

Suppose he is wiring a job with Pipe Taplets. After his splices are finished all he has to do is to push them gently into place with his fingers. Notice the ease with which they go down in the illustration above.

Pipe Taplets have big roomy openings free from cover lugs. There are set screws in the hubs to aid the wireman in aligning the job. Every two sizes of Pipe Taplets take the same size cover, thus cutting the cover stock required in half.

These three features make Pipe Taplets very popular with the wireman for they save his time and make his work easier.

THE HART & HEGEMAN MFG. CO.
HARTFORD, CONN., U.S.A.

"Unilets"

Reg. U. S. Pat. Off.

for

ROUND BASE SNAP SWITCHES

Type "GSC" Unilet Complete

THE "GS" Series of Unilets have been designed to provide a steam, gas, dust, and water-proof enclosure for snap switches and accomodate both 5 and 10 amphere switches.

The operating handle is of rugged design and will stand for a lot of abuse which, the ordinary switch handle would not. This handle is attached to a shaft which passes through a stuffing box securely fastened to the cover, and by means of a fork engages a small piece of brass which is screwed on to switch post and operates the switch.

This small piece of brass is regularly furnished tapped for 8/32 posts, but can be furnished for 6/32 posts, etc., if specified. An interference on the shaft prevents the handle from being turned backward.

The top cover is flanged, fitting over a lapped edge on the Unilet body between which is a rubber gasket. Cover is held in place by four screws, making it absolutely vapor, gas and dust proof. Can be furnished with either Black Enamel or Hot Galvanized finish.

Send for your copy of big, complete catalog of "Unilets" and other Conduit Fittings. Large size 8x10½ or Pocket size 4x5¼. Write today.

Appleton Products include

"Unilets", Outlet Boxes and Covers, Laundry Fittings Locknuts and Bushings, Meter Terminal Fittings, Entrance Fittings, Fuse Wire and Links, "Pagrip" Metal Molding and Fittings, Conduit Clamps and Hangers also Switch Boxes.

APPLETON ELECTRIC COMPANY
227 N. Jefferson Street
CHICAGO

New York 55 Barclay St. | St. Louis 917 Pine St. | San Francisco 221 Second St.

Car and Yard Lighting

ARE

you sure you secure all the light you should per dollar of expenditure?

your cars, yards, offices, shops and stations lighted as well and economically as possible?

you sure your storage batteries, fuse, wire, cable, insulators etc. give the best result?

you? Think and remember E. T. L. Service Assures Greatest Purchasing Efficiency and is a big aid in securing

Proper Lighting at Proper Cost

Electrical Testing Laboratories
80th St. and East End Ave., New York

YAGER'S Soldering Fluxes

YAGER'S Soldering Salts; the original dry salt flux. In ½, 1 and 5 lb. enameled, screw top, friction plug cans.

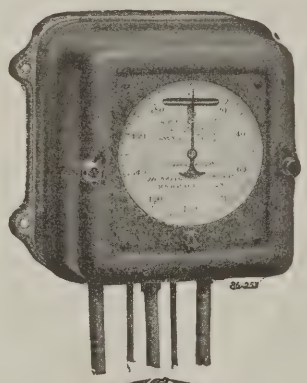
YAGER'S Soldering Paste; a new formula on the base of the old and trusted Yager's Salts. In 2 oz. tins or tubes and ½, 1 and 5 lb. cans.

YAGER'S Soldering Fluid; a concentrated fluid to be diluted to required strength; in 1 gal. cans.

What? Packed in tin? Why sure! Why not? A non-acid, non-corrosive flux will go in tin, and Yager's prove their own claims.

For sale by all up-to-date jobbers. If yours won't supply you, we will.

Alex. R. Benson Company
Hudson, N. Y.



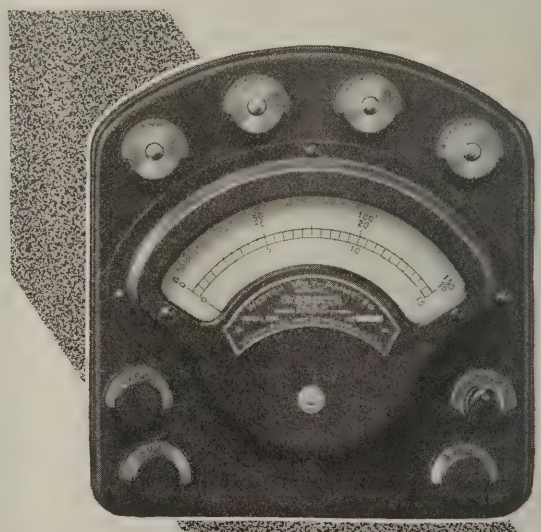
BUILT LIKE A WATCH

AMPEREHOUR METER

protects batteries from destructive overcharging and saves labor and expense.

Licensed for single battery axle lighting systems under U. S. L. patents.

Sangamo Electric Company
Springfield, Illinois
Meters for Every Electrical Need.



Weston Model 280

VOLTAMMETERS

have been approved by the Railway Signal Association as the standard instruments for signal testing.

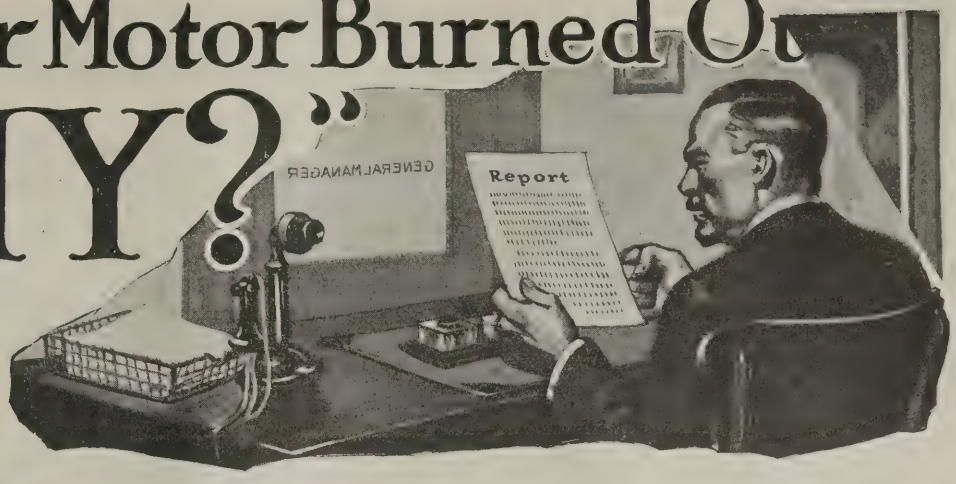
These instruments are high-grade, pocket size, portable, self-contained voltammeters. Their accuracy is within one per cent of full scale value under all normal working conditions.

They are furnished either as double or triple range instruments.

Write for information regarding combinations of ranges specially standardized for Signal Service.

WESTON ELECTRICAL INSTRUMENT CO.,
93 Weston Ave., Newark, N. J.

"Another Motor Burned Out —WHY?"



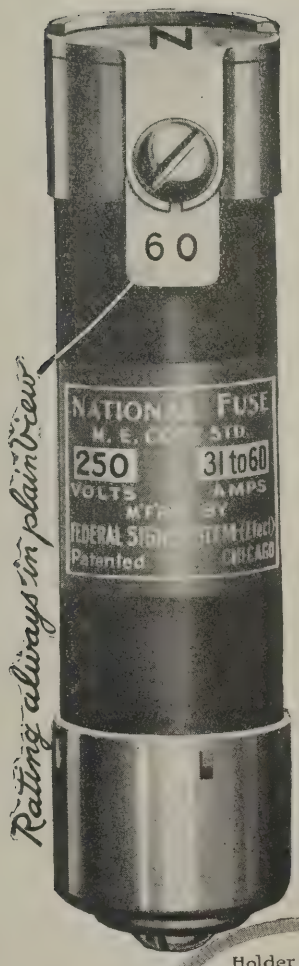
THE answer is simple! The fuse, (which is electricity's safety valve between the motor and the machinery) did not function. It was overloaded, either by having more than one element in it, or by containing an element of the improper rating.

The National Renewable Fuse eliminates this danger, as it is impossible to use more than one element in a holder, and only the proper size element can be used, nor can it be loaded with wire or other foreign elements. The rating is stamped on the metal tell-tale indicator as shown on the left. These two features alone are sufficient reasons for your using National Renewable Fuses.

There are only three parts—it takes but a jiffy, with the assistance of a screw driver, to slip out the blown cartridge and insert a new one.

You save money because the renewable cartridge costs but a small fractional part of the complete fuse. The powder-packed renewable cartridge confines and smothers the fierce heat of the arc when the fuse blows and in this way protects the holder.

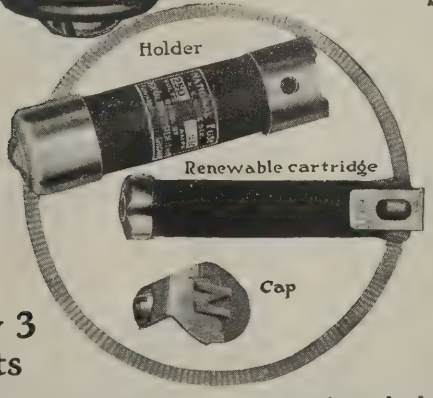
The National Renewable Fuse is the only renewable fuse that is approved by the Associated Factory Mutual Fire Insurance Companies. It is also approved by the Millers Mutual Fire Insurance Companies and meets every performance test of the Underwriter's Laboratories. Send coupon for full information.



The NATIONAL Renewable FUSE

Send Coupon NOW!

FEDERAL ELECTRIC COMPANY
Representing Federal Sign System (Electric)
LAKE AND DESPLAINES STREETS, CHICAGO
618 Mission Street, SAN FRANCISCO, CAL.
627-649 West 43rd Street, NEW YORK, N. Y.
Branches in all large cities



Only 3 Parts

We make a complete line of renewable fuses, both 250 and 600 volts, up to and including 600 amperes.

FEDERAL ELECTRIC COMPANY, Representing
Federal Sign System (Electric), Lake and Desplaines Sts., Chicago

Please send full information and prices of National Renewable Fuses.

Name _____

Address _____

Company _____

Dealer's Name and Address _____

R.E.E.12

Copper Wire, Rods, Tubes
Brass Wire, Rods, Tubes
Bronze Wire and Rods
Copper Clad Steel Wire
Magnet and Weatherproof Wire
Rubber Insulated Wire
Lead Covered Cables
Armored Cables
Cable Terminals
Cable Junction Boxes
Insulating Compounds
Paper Jointing Tubes
etc., etc.

WE have every facility for meeting your requirements of these products promptly and satisfactorily. As to the service value of *Standard* Wires and Cables, we will gladly refer you to a long list of satisfied customers who have used them for many years.

Standard Underground Cable Co.
Pittsburgh, Pa.

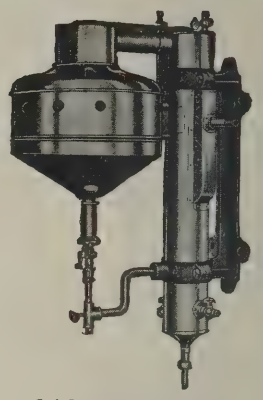
Boston, New York, Philadelphia, Pittsburgh, Chicago, St. Louis, Minneapolis, San Francisco
For Canada: Standard Underground Cable Co. of Canada, Limited, Hamilton, Ont.

Batteries That Fail

Storage Battery Efficiency Demands Pure Water

"The Better the Still—the Better the Water"

Operated with Gas, Gasoline, Kerosene, Steam or Electricity



GAS OPERATED

How many batteries die prematurely? The failure is often hastened by impure water. Iron, chlorine and nitrates all increase local action and the deterioration of the elements.

The Improved Automatic Rochlitz Water Still

automatically supplies a stream of pure distilled water.

Production costs are a minimum.
Send for figures and testimonials.
Standardized on fifty railroads.

With distilled water on hand you can purchase C. P. Acid and reduce it to proper battery strength, thus saving transportation charges on carboys and water.

MANUFACTURED BY
W. M. LALOR CO., Manhattan Bldg., Chicago, U. S. A.

CLASSIFIED ADVERTISEMENTS

POSITIONS OPEN

EMPLOYERS—Send us your inquiries for men of technical training and experience. We are obtaining employment for soldiers, sailors and marines released from service. Re-Employment Bureau of New York City for Soldiers, Sailors and Marines, 505 Pearl Street, north of Municipal Building, Professional Section, Worth 9250.

SALESMAN experienced in dealing with Steam Railroad Purchasing Agents and Motive Power Officials in the sale and installation of Steam and Electrical specialties used on locomotives. A practical knowledge of conditions met with in Railroad Shops, Roundhouses and on the locomotive is necessary. Must have demonstrated sales and executive ability. Give full information as to experience, age, whether married or single and present salary. Address Box 126. Railway Electrical Engineer, Woolworth Bldg., New York, N. Y.

POSITIONS WANTED

WANTED:—A position by young man with 10 years' experience and technical education. At present employed as Electrical Foreman in charge of Headlight, Axle-light, and general shop work of five shops and terminals of a prominent southern railroad. Reason for wanting to make a change is to secure different climate for family. References on request. Address Box 125. RAILWAY ELECTRICAL ENGINEER, Woolworth Bldg., New York, N. Y

POSITION WANTED, with chance for advancement, by an experienced electric railway repairman, experienced in armature winding and spinning controller overhauling, car wiring and general shop wok. Would like to locate in western states. Address Box 127, Railway Electrical Engineer, Woolworth Bldg., New York, N. Y.

MISCELLANEOUS

We want to buy back copies and sets of Railway Electrical Engineer's and other technical periodicals. International Magazine Co., Elizabeth, N. J.

A classified advertising section will be incorporated in this publication whenever necessary.

Use this service when seeking a new man, a new position, or when buying or selling second-hand equipment.

Rate is 5c. a word a month. Minimum charge 1.00. Remittance must accompany each order.

RAILWAY ELECTRICAL ENGINEER
Woolworth Building **New York**

SUNBEAM

U. S. Standard Interchangeable
Electric Headlight and Turbo-Generator

THIS modern locomotive headlight equipment has but few working parts and these working parts are readily accessible for repairs, replacements or adjustments.

No need to tear equipment to pieces to get at some mechanical part—no holding engine out of service unnecessarily for some minor repairs. One man can completely dismantle a Sunbeam generator in 5 minutes.

Interior of Sunbeam headlight is accessible through side number doors. Or, interior can be pulled out for inspection by means of two rings attached to the slide.

Write for Sunbeam Folder No. 1 and the Modern Loco. Headlight textbook which fully describe and illustrate this efficient headlight equipment. No obligations attached.

Installing "Sunbeams" on a big railroad system

Pattern 1018
"Welded of Course"

SCHROEDER SUNBEAM HEADLIGHTS & TURBO-GENERATORS

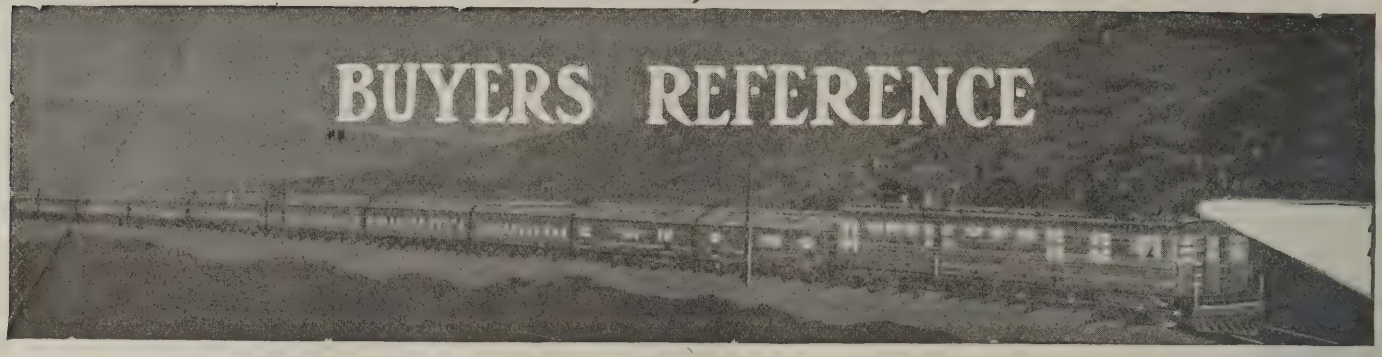
SUNBEAM ELECTRIC MANUFACTURING CO.
(Formerly Schroeder Headlight & Generator Co.)

America's Foremost Headlight Builders for 32 years

EVANSVILLE **INDIANA, U. S. A.**

NEW YORK	ST. LOUIS	CHICAGO	SAN FRANCISCO
50 Church St.	214 N. 6th St.	1510 McCormick Bldg.	507 New Call Bldg.

BUYERS REFERENCE



AMMETERS
Weston Electrical Instrument Co.

ARC WELDING EQUIPMENT
Electric Arc Cutting & Welding Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

ARRESTORS, LIGHTNING
Electric Service Supplies Co.
General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

AXLE DRIVEN GENERATORS
(See Car Lighting Equipment)

AXLE PULLEYS
Dodge Sales & Engineering Co.

AXLE PULLEY BUSHINGS
Dodge Sales & Engineering Co.

BATTERIES, STORAGE
Edison Storage Battery Co.
Electric Storage Battery Co.
Gould Coupler Co.
Safety Car Heating & Lighting Co.
Western Electric Co.
U. S. Light & Heat Corp.

BATTERY CHARGING APPARATUS
Anderson Mfg. Co., Albert & J. M.
Cutler-Hammer Mfg. Co.
General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

BEARINGS, AXLE GENERATOR
Fafnir Bearing Co.
Gurney Ball Bearing Co.
Oliver Electric & Mfg. Co.
S. K. F. Industries, Inc.

BEARINGS, BALL
Fafnir Bearing Co.
Gurney Ball Bearing Co.
S. K. F. Industries, Inc.

BEARINGS, BALL THRUST
Fafnir Bearing Co.
Gurney Ball Bearing Co.
S. K. F. Industries, Inc.

BELTING, AXLE GENERATOR
Goodrich Rubber Co., B. F., The

BONDS, RAIL
Electric Service Supplies Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

BOXES, CABLE JUNCTION
Standard Underground Cable Co.

BOXES, CONDUIT OUTLET
Central Electric Co.

BOXES, SWITCH
Appleton Electric Co.
Adapti Co.
Central Electric Co.
Crouse-Hinds Co.
National Metal Molding Co.

BRAKES, ELECTRIC
Cutler-Hammer Mfg. Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

CAB LIGHTING FIXTURES
Appleton Electric Co.
Central Electric Co.
Crouse-Hinds Co.
Oliver Elec. & Mfg. Co.

CABINETS
Benjamin Electric Mfg. Co.
Central Electric Co.
Frank Adam Electric Co.
Hart & Hegeman Mfg. Co.
Trumbull Electric Mfg. Co.

CABLE, ARMORED AND LEAD COVERED
Central Electric Co.
General Electric Co.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
National Metal Molding Co.
Sprague Electric Works of the General Electric Co.
Standard Underground Cable Co.
Trumbull Electric Mfg. Co., The
Western Electric Co.

CABLE, INSULATED
Central Electric Co.
General Electric Co.
Goodrich Rubber Co., B. F., The
Habirshaw Electric Cable Co., Inc.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Standard Underground Cable Co.

CABLE, TELEPHONE
Central Electric Co.

CABLE TERMINALS
Electric Service Supplies Co.
Standard Underground Cable Co.
Western Electric Co.

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Benjamin Electric Mfg. Co.
Electric Storage Battery Co., The
Gould Coupler Co.
Safety Car Heating & Lighting Co.
Stone Franklin Co.
U. S. Light & Heat Corp.

CAR LIGHTING GENERATORS
Stone Franklin Co.

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Central Electric Co.

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General Electric Co.
Sangamo Electric Co.
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CIRCUIT BREAKERS, OIL
General Electric Co.
Westinghouse Electric Co.

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Cutler-Hammer Mfg. Co.

COMPRESSORS, AIR
General Electric Co.

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Adapti Co.
Appleton Electric Co.
Central Electric Co.
Crouse-Hinds Co.
Hart & Hegeman Mfg. Co.
National Metal Molding Co.

CONDUIT, FLEXIBLE METALLIC
Central Electric Co.
National Metal Molding Co.
Sprague Electric Works of the General Electric Co.

CONDUIT, RIGID
Central Electric Co.
National Metal Molding Co.
Sprague Electric Works of the General Electric Co.

CONTROL APPARATUS
Safety Car Heating & Lighting Co.

COPPER RODS AND TUBES
Standard Underground Cable Co.

CUTOUTS, ENTRANCE
Appleton Electric Co.
Crouse-Hinds Co.
Hart & Hegeman Mfg. Co.
Trumbull Electric Mfg. Co., The

CUTOUTS, PLUG AND PANEL
Crouse-Hinds Co.
Hart & Hegeman Mfg. Co.
Trumbull Electric Mfg. Co., The

DYNAMOS
Stone Franklin Co.

ELECTRIC GENERATORS
Stone Franklin Co.

ELECTRICAL APPARATUS AND SUPPLIES
Benjamin Electric Mfg. Co.
Central Electric Co.
Electric Service Supplies Co.
General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

ELECTRIFICATION CONSTRUCTION MATERIALS
Ohio Brass Co.

ELECTRIFICATION OF STEAM ROADS
General Electric Co.
Westinghouse Electric & Mfg. Co.

FANS, CAR
Central Electric Co.
General Electric Co.
Safety Car Heating & Lighting Co.
Westinghouse Electric Mfg. Co.

FANS, DESK AND BRACKET
Central Electric Co.
General Electric Co.
Western Electric Co.
Westinghouse Electric Mfg. Co.

FIXTURES.
Appleton Electric Co.

FIXTURES, CAR LIGHTING
Crouse-Hinds Co.
Oliver Elec. & Mfg. Co.
Safety Car Heating & Lighting Co.

FIXTURES, GAS AND VAPOR PROOF
Benjamin Electric Mfg. Co.
Cutter Co., Geo.

FIXTURES, OFFICE, SHOP AND YARD LIGHTING
Benjamin Electric Mfg. Co.
Central Electric Co.
Cutter Co., Geo.
Hubbell, Inc., Harvey

FREIGHT CONVEYOR SYSTEMS, ELECTRIC
Sprague Electric Works of the General Electric Co.

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Appleton Electric Co.
Central Electric Co.
Federal Sign System (Electric)
General Electric Co.

FUSES, PLUG
Federal Sign System (Electric)

FUSES, REFILLABLE
Central Electric Co.
Federal Sign System (Electric)

GENERATORS
Safety Car Heating & Lighting Co.

GENERATORS, AXLE DRIVEN
Safety Car Heating & Lighting Co.

GENERATORS, CAR LIGHTING
Electric Storage Battery Co.
Gould Coupler Co.
Stone Franklin Co.
U. S. Light & Heat Corp.

GENERATORS, HEAD-END
Gould Coupler Co.

GENERATORS, POWER AND LIGHTING
General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

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Ohio Brass Co.

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Crouse-Hinds Co.
Electric Service Supplies Co.
General Electric Co.
Sunbeam Electric Mfg. Co.

HEADLIGHT TURBO GENERATORS
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General Electric Co.
Sunbeam Electric Mfg. Co.

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Sprague Electric Works of the General Electric Co.

HOSE, AIR STEAM, ETC.
Goodrich Rubber Co., B. F.
Sprague Electric Works of the General Electric Co.

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(See Meters)

INSTRUMENTS (ELECTRICAL MEASURING)
Weston Electrical Instrument Co.

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Electric Service Supplies Co.
Standard Underground Cable Co.

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General Electric Co.
Westinghouse Electric & Mfg. Co

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(See Laboratories)

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Ohio Brass Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

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Ohio Brass Co.

INSULATORS, THIRD RAIL
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Ohio Brass Co.

INTER-COMMUNICATING TELEPHONES.
Western Electric Co.

LABORATORIES
Electrical Testing Laboratories

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Electric Service Supplies Co.

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Electric Service Supplies Co.
National Lamp Works of the General Electric Co.

LAMPS, INCANDESCENT
National Lamp Works of the General Electric Co.

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Central Electric Co.

LIGHTING UNITS, FLOOD
(See Projectors, Flood Light)

LIGHTING UNITS, INDOOR AND OUTDOOR
Benjamin Electric Mfg. Co.
Central Electric Co.
Cutter Co., Geo.
Hubbell, Inc., Harvey

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General Electric Co.
Ohio Brass Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

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General Electric Co.
Westinghouse Electric & Mfg. Co.

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Westinghouse Electric & Mfg. Co.

MAGNETS, LIFTING
Cutler-Hammer Mfg. Co., The

MECHANICAL RUBBER GOODS
Goodrich Rubber Co., B. F., The

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National Metal Molding Co.

METERS. A. C. AND D. C., PORTABLE
Westinghouse Electric & Mfg. Co.
Weston Electrical Instrument Co.

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General Electric Co.
Sangamo Electric Co.
Westinghouse Electric & Mfg. Co.

METERS, A. C. AND D. C., SWITCHBOARD
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Sangamo Electric Co.
Weston Electrical Instrument
Westinghouse Electric & Mfg. Co.

METERS, A. C. AND D. C., WATT HOUR
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Sangamo Electric Co.
Westinghouse Electric & Mfg. Co.

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"600 STRONG"

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The "Super" said, "Yes, we have 600 Trumbull Safety Switches in the shop—but you'd never know it. We install them and then forget about them. They give us absolutely no trouble, they protect our equipment, our men and our organization." You cannot open box until switch is in "off" position—cannot close switch until box is closed—cannot touch a live part.

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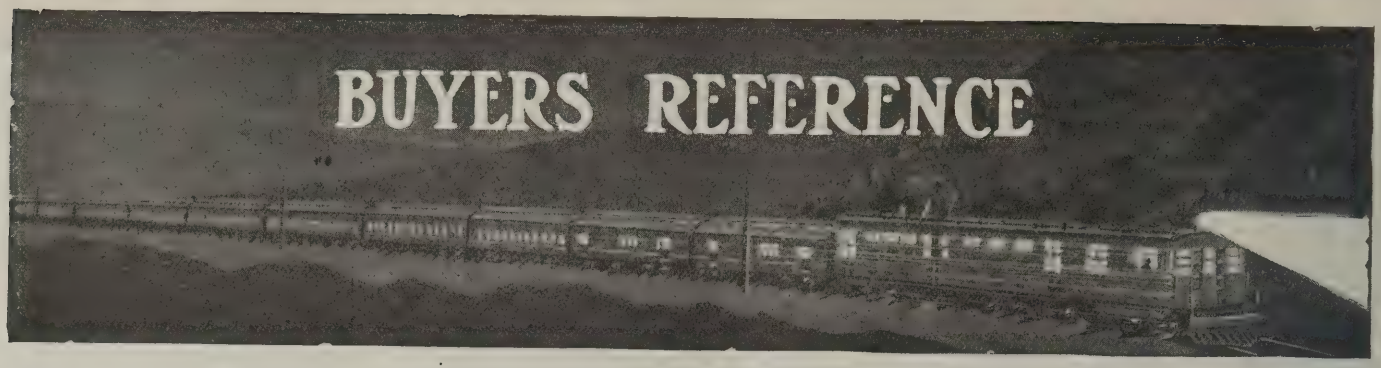

METERS, AMPERE HOUR
Sangamo Electric Co.

METERS (CHEMICAL MEASURING)
Weston Electrical Instrument Co.

METERS (ELECTRICAL TESTING)
Weston Electrical Instrument Co.

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General Electric Co.
Sprague Electric Works of the General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

MOTORS, A. C. AND D. C.
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General Electric Co.
Sprague Electric Works of the General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

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Westinghouse Electric & Mfg. Co.

OHMETERS
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Benjamin Electric Mfg. Co.
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Cutter Co., Geo.
Frank Adam Electric Co.
Hart & Hegeman Mfg. Co.
Sprague Electric Works of the General Electric Co.
Trumbull Electric Mfg. Co., The

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Central Electric Co.
Crouse-Hinds Co.

PLUGS AND RECEPTACLES, BATTERY CHARGING.
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Central Electric Co.
Crouse-Hinds Co.

PLUGS AND RECEPTACLES, ATTACHMENT
Appleton Electric Co.
Benjamin Electric Mfg. Co.
Cutler-Hammer Mfg. Co.
Hart & Hegeman Mfg. Co.
Hubbell, Inc., Harvey
Trumbull Electric Mfg. Co., The

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Crouse-Hinds Co.
Oliver Electric & Mfg. Co.

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Electric Service Supplies Co.
Western Electric Co.

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Cutter Co., Geo.
Central Electric Co.
Electric Service Supplies Co.
Hubbell, Inc., Harvey
Ivanhoe Regent works of General Electric Co.
Safety Car Heating & Lighting Co.
Wheeler Reflector Co.

REFLECTORS, CAR LIGHTING
Safety Car Heating & Lighting Co.

REGULATORS, CAR LIGHTING
Electric Storage Battery Co.
Gould Coupler Co.
U. S. Light & Heat Corp.

REGULATORS, GENERATOR
Safety Car Heating & Lighting Co.

REGULATORS, LAMP
Safety Car Heating & Lighting Co.

REPAIR PARTS, AXLE LIGHTING EQUIPMENT
Oliver Electric & Mfg. Co.

REPAIR PARTS, ELECTRIC HEADLIGHT
Oliver Electric & Mfg. Co.

RHEOSTATS, FIELD
Cutler-Hammer Mfg. Co., The
General Electric Co.
Westinghouse Electric Mfg. Co.

SELECTIVE APPARATUS FOR TRAIN DISPATCHING
Western Electric Co.

SHADE HOLDERS
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Cutter Co., Geo.
Hubbell, Inc., Harvey

SHOP AND YARD LIGHTING
Oliver Electric & Mfg. Co.

SIGNAL SYSTEMS, INDUSTRIAL
Benjamin Electric Mfg. Co.

SOCKETS AND RECEPTACLES, LAMP
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Cutler-Hammer Mfg. Co., The
Cutter Co., Geo.
Hart & Hegeman Mfg. Co.
Hubbell, Inc., Harvey

SOCKETS, LAMPS
Central Electric Co.

SOLDERING COMPOUNDS
Benson Co., Alex. R.

SOLDERING IRONS, ELECTRIC
Cutler-Hammer Mfg. Co., The

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Edison Storage Battery Co.
Electric Storage Battery Co.
Gould Storage Batttery Co.
U. S. Light & Heat Corp.

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Anderson Co., A. & J. M.
General Electric Co.
Frank Adam Electric Co.
Trumbull Electric Mfg. Co., The
Westinghouse Electric & Mfg. Co.

SWITCHES, AUTOMATIC TIME
Anderson Co., A. & J. M.

SWITCHES, ENCLOSED (SAFETY)
Appleton Electric Co.
Crouse-Hinds Co.
General Electric Co.
Trumbull Electric Mfg. Co., The
Western Electric Co.
Westinghouse Electric & Mfg. Co.

SWITCHES, END CELL
Anderson Co., A. & J. M.

SWITCHES, FROG, ETC.
Appleton Electric Co.

SWITCHES, HEAD LIGHT
Electric Service Supplies Co.

SWITCHES, KNIFE
Anderson Co., A. & J. M.
Appleton Electric Co.
Cutter Co., Geo.
General Electric Co.
Frank Adam Electric Co.
Hart & Hegeman Mfg. Co.
Trumbull Electric Mfg. Co., The
Westinghouse Electric & Mfg. Co.

SWITCHES, SNAP, PUSH AND PENDANT
Benjamin Electric Mfg. Co.
Cutler-Hammer Mfg. Co., The
Hart & Hegeman Mfg. Co.
Trumbull Electric Mfg. Co., The

SYNCHROSCOPES
Weston Electric Instrument Co.

TELEPHONE APPARATUS
Western Electric Co.

TEXT BOOKS
American Technical Society

TOOLS
Benjamin Electric Mfg. Co.

TRANSFORMERS, INSTRUMENT
General Electric Co.
Westinghouse Electric & Mfg. Co.
Weston Electrical Instrument Co.

TRANSFORMERS, POWER AND LIGHTING
Electric Service Supplies Co.
General Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

VOLT METERS
Weston Electrical Instrument Co.

WATER STILL
W. M. Lalor Co.

WATT METERS
Weston Electrical Instrument Co.

WIRE, BARE
Standard Underground Cable Co.
Western Electric Co.

WIRE, CONNECTING
Appleton Electric Co.

WIRE, COPPER CLAD STEEL
Standard Underground Cable Co.

WIRE, INSULATED
Central Electric Co.
General Electric Co.
Goodrich Rubber Co., B. F., The
Habirshaw Electric Cable Co., Inc.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Okonite Co.
Standard Underground Cable Co.
Western Electric Co.

WIRE, LOCOMOTIVE HEADLIGHT
Habirshaw Electric Cable Co., Inc.

WIRE, TELEPHONE AND TELEGRAPH
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Okonite Co.
Standard Underground Cable Co.
Western Electric Co.

WIRE, TROLLEY
Standard Underground Cable Co.

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How To Bring Down The H.C.L.

BRINGING down the H. C. L. is a big problem today—today when costs are so high. But there is a way, a sure way, to bring down your H. C. L. (High Cost of Lighting) and it is found in

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Cutter Equipment is a Cost Cutter wherever installed for

CUTTER HOLDER SOCKETS save time in installation—*two minutes of one man's time*, that's all the time required, after that they save time by permitting quick cleaning of reflectors.

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Then here is another Cutter Cost Cutter that will help bring down the H. C. L.

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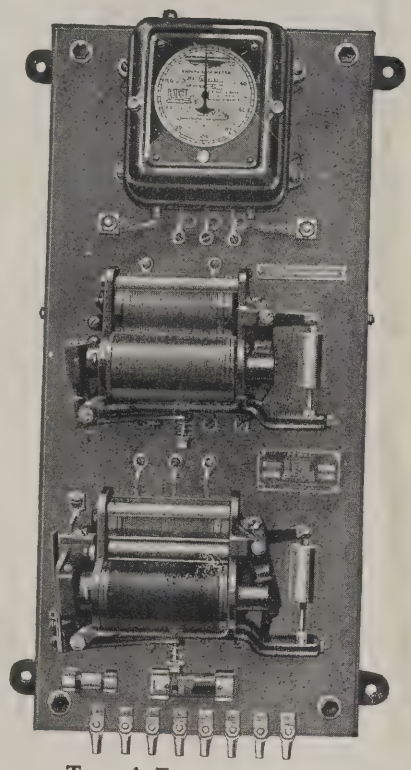
Car-Lighting Equipments
For Coaches and Baggage Cars

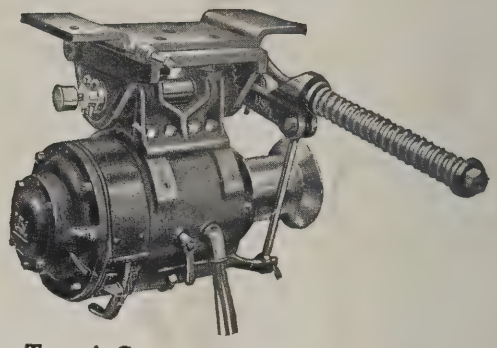


Type A Form 201 Panel

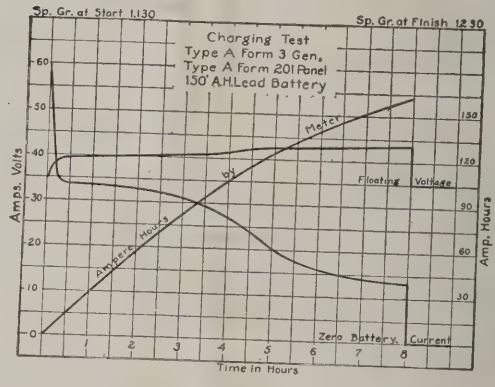
USL
U.S. LIGHT & HEAT CORPORATION

Type A

1 1-2 K. W. Axle Device



Type A Generator with Body Suspension



The USL Type A Panel, Generator and Body-Hung Suspension were designed and developed to meet the demand for a small, compact, efficient and inexpensive equipment for coaches, baggage cars, etc.

This USL Type A Equipment embodies all of the improved features in design and construction of the widely used USL equipments of greater capacity. Furthermore the type A Panel, upon which are mounted the Ampere-Hour-Meter, Generator Regulator with Automatic Switch and Lamp Regulator occupies a space in the car locker of only 12 x 36 inches.

The most important feature however, is the **Ampere Hour Meter Control,** which insures maximum battery protection with lowest operating costs.

Write for Bulletin 212

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Branches: New York Chicago Detroit Kansas City San Francisco Washington, D. C.